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DELTA II

Ice, Cloud, and Land Elevation Satellite (ICESat) Mission Specification

Ice, Cloud, and Land Elevation Satellite (ICESat) Mission Specification

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CONTENTS

FIGURES

TABLES

1 SCOPE

The purpose of this document is to:

a. Describe the spacecraft

b. Present the mission requirements associated with orbit criteria, injection accuracy, launch time, and tracking requirements.

c. Present special vehicle or mission-peculiar requirements that are not defined, or are more precisely defined, than those specified in MDC 96H0145, Delta II Med-Lite Payload Planners Guide.

d. Describe the ground handling and processing requirements needed to meet mission and spacecraft objectives.

e. Describe the launch vehicle environments that will be imposed on the spacecraft

f. Present information regarding the verification of these requirements.

g. Present additional documents or drawings that further define the interface.

It is a requirement to furnish a launch vehicle, spacecraft, and launch vehicle facilities that not only satisfy the requirements specified in this document but also satisfy the constraints specified for the spacecraft in the Delta II Med-Lite Payload Planners Guide.

2 APPLICABLE AND REFERENCE DOCUMENTS

The specific revisions of the following documents form a part of this specification to the extent specified herein:

2.1 APPLICABLE DOCUMENTS

FED-STD-209E 15 June 1988	Airborne Particulate Cleanliness, Cleanrooms and Clean Zones
MDC 96H0145 1 August 1996	Delta II Med-Lite Payload Planners Guide
MIL-STD-1246C	Product Cleanliness Levels and Contamination Control Program

2.2 REFERENCE DOCUMENTS

183634	ICESat - Delta Launch Vehicle ICD (Ball Aerospace Document)
536986	Final Assembly and Installation, Propulsion Module (Ball Aerospace Drawing)
545550	ICESat Dynamic Envelope (Ball Aerospace Drawing)
MDC 99H0062 (Draft)	Cooperative Astrophysics and Technology Satellite (CATSAT) Mission Specification
MIL-STD-1522A 28 May 1984	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
STP0407-03 28 March 1995	Cleanliness Requirements for Space Vehicle Shrouds
TBD	ICESat Missile System Prelaunch Safety Package (MSPSP), Ball Aerospace
VB-B2/ICE/CAT-TOD-002 7 June 1999	Spacecraft Questionaire, ICESat

2.3 ORDER OF PRECEDENCE

In the event of a conflict between the text of this specification and any of the documents cited herein, the text of this specification takes precedence unless indicated otherwise.

3 REQUIREMENTS

3.1 SPACECRAFT CONFIGURATION

3.1.1 SPACECRAFT DESCRIPTION

The Ice, Cloud, and Land Elevation Satellite (ICESat) mission is part of the Earth Observing System (EOS) multi-mission program to acquire the data necessary for the long-term study and understanding of Earth's global processes and systems. The science themes which will be examined are: the mass balance and topography of the polar ice sheets, cloud heights and vertical structure, aerosols, and topography of land.

ICESat is a 3-axis stabilized, self-contained free flyer designed to carry and support the Geoscience Laser Altimeter System (GLAS) instrument. GLAS, an integral part of the EOS program, is a satellite laser altimeter designed to measure ice-sheet topography and associated temporal changes, as well as cloud and atmospheric properties. Operation of GLAS over land and water will provide along-track topography. The GLAS includes a laser system to measure distance, a receiver of signals from the Global Positioning System of satellites, and a star-tracker attitude-determination system. The laser will transmit short pulses (4-6 ns) of infrared light (1064 nanometers wavelength) and visible-green light (532 nanometers). Photons reflected back to the spacecraft from the surface of the Earth and from the atmosphere, including the interior of clouds, will be collected in a 1 Meter diameter Beryllium telescope. Laser pulses at 40 times per second will illuminate spots (footprints) 70 meters in diameter, spaced at 175-meter intervals along Earth's surface. The spacecraft on-orbit configuration is shown in Figure 3-1, Spacecraft On-Orbit Configuration. The launch configuration is shown in Figures 3-2 and 3-3, Spacecraft Launch Configuration.

3.1.2 SPACECRAFT COORDINATE SYSTEM

The spacecraft coordinate system and launch vehicle coordinate system shall be in accordance with Figures 3-4 and 3-5, Spacecraft and Launch Vehicle Coordinate Systems. The spacecraft +Z axis is along the launch vehicle +X axis. The spacecraft XY plane (coordinate set origin) is 8.0 inches above the launch vehicle/spacecraft separation plane. The spacecraft Y axis is equal to the launch vehicle Y axis plus 45 (TBR) degrees.

3.1.3 SPACECRAFT MASS PROPERTIES (LAUNCH CONFIGURATION)

3.1.3.1 Weight, Moments and Products of Inertia, and C. G. Location

The spacecraft weight, moments of inertia (MOI), products of inertia (POI), and center of gravity (CG) location shall be in accordance with Table 3-1, Spacecraft Weight, MOI, POI, and CG Location. The nominal weight of the spacecraft is 1020 kg (2248.7 lbs) (TBR) with a minimum of 1010 kg (2226.7 lbs) (TBR) and a maximum of 1030 kg (2270.8 lbs) (TBR).

3.1.3.2 C. G. Offset

The spacecraft total lateral center of gravity offset from the launch vehicle (LV) X-axis shall not exceed 3.0 in. (76.2 mm) radially, including uncertainties. The location of the spacecraft (SC) center of gravity along the LV X-axis shall not exceed 55 in. (1397 mm), including uncertainties, from the SC-LV interface plane. (Note: spacecraft tip-off rates are a function of CG offset).

3.1.4 SPACECRAFT ENVELOPE

The spacecraft allowable envelope shall be accordance with Figure 3-6, Payload Fairing Envelope.

3.1.4.1 Fairing Envelope Violations

The fairing envelope violations shall be as shown in Table 3-2, Violations in the Fairing Envelope (TBD).

3.1.4.2 Separation Plane Envelope Violations

The spacecraft thrusters and star tracker violate the separation plane envelope. The SC-LV interfaces at the separation plane are shown in Figure 3-7, Spacecraft/LV Separation Plane Interfaces. All envelope exceedances shall be as shown in Table 3-3, Violations in the Separation Plane Envelope.

3.1.5 SPACECRAFT ENERGY DISSIPATION SOURCES

The GLAS instrument radiators/loop heat pipes dissipate energy. Details are TBD.

3.1.6 SPACECRAFT HAZARDOUS SYSTEMS

Spacecraft hazardous systems information is included in this document for information only. The ICESat Missile System Prelaunch Safety Package (MSPSP) will contain the official hazardous systems information.

3.1.6.1 Propulsion Systems

ICESat utilizes a hydrazine mono-propellant pressurized with gaseous nitrogen (GN2) and used in a blowdown system that delivers thrust for orbit acquisition, orbit maintenance, and three axis attitude control. The propulsion system consists of a single tank containing 167.6 lb (76 kg) (TBR) of ultra-pure hydrazine. The fill fraction is 83% with 721 in^3 GN2 as pressurant.

3.1.6.1.1 Propellant Tank

The propellant tank characteristics are summarized in Table 3-4, Propellant Tank Characteristics. See also Ball Aerospace Drawing 536986, Final Assembly and Installation, Propulsion Module.

3.1.6.1.2 Propellant Tank Pressurization

The propellant tank is a diaphragm tank, which does not require a separate pressurant tank. The tank will be pressurized as part of the observatory fueling operation.

3.1.6.2 Non-Propulsion Pressurized Systems

The GLAS instrument contains seven unique axial grooved ammonia-charged heat pipes and two propylene-charged closed loop heat pipes. These heat pipes and loop heat pipes may reach high pressures. If any of these pipes were to rupture, the working fluid would be a hazard. This is because ammonia and propylene are flammable and ammonia is a health hazard. The maximum non-operating pressure the ammonia heat pipes could reach is 41 bar. Each ammonia heat pipe contains approximately 30 grams of ammonia. Ammonia is flammable in certain ammonia/air combinations and can damage human respiratory systems. The two propylene loop heat pipes contain about 300 grams of propylene each. To prevent rupture, the heat pipes and loop heat pipes are designed and tested per MIL-STD-1522A.

3.1.6.3 Spacecraft Batteries

The ICESat spacecraft has one battery. The spacecraft battery characteristics are summarized in Table 3-5, Spacecraft Battery. The battery will arrive at the launch site pressurized, and will be maintained in the operating range of 600 - 1100 psi through launch.

3.1.6.4 RF Systems

The RF system for ICESat has 7 TT&C antenna elements and 2 GPS antenna elements. TT&C antenna elements reside on 2 separate antenna assemblies, installed on opposite sides of the spacecraft bus. The -X, or Nadir, side of the spacecraft has the TT&C antenna assembly with 5 elements; 2 X-Band transmit elements, 2 S-Band transmit elements and 1 S-Band receive element. The +X, or Zenith, side of the spacecraft has a TT&C antenna assembly with 2 elements; 1 S-Band transmit element and 1 S-Band receive element.

a. Only 1 X-Band transmitter will be powered at a time, radiating out of a dedicated antenna element. Once the spacecraft leaves Building 1610, the X-Band transmitters will not be turned on again until several days after launch.

b. Only 1 S-Band transmitter will be powered at a time, radiating out of either 1 Nadir antenna element, or omni-directional out of the other Nadir element and the Zenith element at the same time.

c. Transmitters will only be powered on for functional tests at the Payload Processing Facility (RF integration testing is performed at the spacecraft contractor’s facility).

d. The transmitters will not be activated again until after separation from the launch vehicle.

e. The S-Band receive elements are both coupled to both spacecraft command receivers for omni-directional coverage. The S-Band receivers will operate continuously whenever the spacecraft has power applied to the essential bus, including operation during all phases of launch operations.

f. GPS antenna elements are each connected to a dedicated receiver (L1 and L2 frequencies). GPS receivers will only be powered on for functional tests at the Payload Processing Facility.

g. GPS receivers will not be activated again until after separation from the launch vehicle.

3.1.6.4.1 RF Characteristics

The ICESat RF transmitters, one X-Band and one S-Band, and S-Band receiver characteristics are summarized in Table 3-6, RF Transmitter and Receiver Characteristics.

3.1.6.4.2 RF Radiation Levels (Personnel Safety)

The ICESat RF system transmitters will not be turned on while the spacecraft is mated to the launch vehicle hardware. Each transmitter on/off path requires two switches to be activated for operation. Therefore, inadvertent power-up of each transmitter is prevented by dual inhibits. The spacecraft receivers are on during launch.

3.1.6.5 Deployable Systems

3.1.6.5.1 Antennas

There are no deployable antennas on the spacecraft.

3.1.6.5.2 Solar Panels

The Retain and Release System (RRS) is used to hold the Solar Array wings in the stowed position until spacecraft separation from the launch vehicle and to deploy the wings immediately following separation. Each wing has five hold down points, two for each winglet and one for each center panel. Each RRS mechanism consists of a titanium bolt, which provides a preload for a structural interface between the solar panel and the spacecraft. A shaped-memory alloy element within the mechanism expands when heated until the titanium bolt fails in tension at a neck-down point. The shaped-memory alloy element has 2 separate heater elements for redundancy. Either element can heat the device to cause a release. Array deployment sequence is part of the default Command Storage Memory (CSM) load that begins to execute after the Spacecraft Control Computer (SCC) is initialized following separation from the launch vehicle. Umbilical connector separation powers the SCC which, in turn, initializes the CSM. Electrical power for the heater elements is first routed through the "Hazard Bus" relays within the Power Control Unit, then through an arming connector accessible from outside the spacecraft, and finally through control switches that apply power to selected mechanisms in sequence. The spacecraft Solar Array is designed to remain in the stowed position until spacecraft separation from the launch vehicle.

3.1.6.6 Radioactive Devices

There are no radioactive devices on the spacecraft.

3.1.6.7 Electro-Explosive Devices

There are no electro-explosive devices on the spacecraft.

3.1.6.8 Non-EED Release Devices

The non-EED ordnance and release devices are listed in Table 3-7, Non-EED Release Devices.

3.1.6.9 Other Hazardous Systems

The GLAS instrument contains three identical diode-pumped, Q-switched Nd:YAG lasers. Only one is used at a time; the other 2 provide redundancy and increase the predicted mission lifetime. When in use, the laser produces 4 ns to 6 ns pulses of 532 nm and 1064 nm light. Each laser pulse contains 75 mJ at 1064 nm and 35 mJ at 532 nm. Thus, although the average output power is only 4.4 W, the laser emits 27.5 MW of power during each of the 4 ns pulses. Because of the high output power, the lasers have the potential to cause injury to personnel and damage to flight hardware. The lasers are rated as Class 4 lasers. Both ANSI and NASA standards will be followed to minimize risks.

3.1.7 CONTAMINATION SENSITIVE SURFACES

Contamination sensitive surfaces on the spacecraft are identified in Table 3-8, Contamination Sensitive Surfaces.

3.1.8 SPACECRAFT VOLUME

3.1.8.1 Ventable

TBD

3.1.8.2 Non-Ventable

TBD

3.1.9 SPACECRAFT SYSTEMS ACTIVATED PRIOR TO SPACECRAFT SEPARATION

The spacecraft systems activated prior to spacecraft separation shall be in accordance with Table 3-9, Spacecraft Systems Activation.

3.1.10 SPACECRAFT RF SYSTEMS ACTIVATED AFTER SPACECRAFT SEPARATION

The Observatory transmitters will be activated TBD seconds after separation from the launch vehicle. The X-Band system will not be turned on until several days after launch.

3.2 MISSION PARAMETERS

3.2.1 ORBIT CHARACTERISTICS

The desired orbit for the ICESat spacecraft is in a near-circular orbit at an altitude of 590 km (TBR) with an inclination of 94˚ (TBR). The osculating orbit parameters at SECO 2 shall be in accordance with Table 3-10, Orbit Characteristics.

3.2.2 INJECTION ACCURACY

The Delta orbit accuracy will be defined in the Preliminary Mission Analysis (PMA). The spacecraft three-sigma orbit dispersion requirements shall be in accordance with Table 3-11, Orbit Dispersion Requirements (TBR).

3.2.2.1 Probability of Command Shutdown

The probability of command shutdown (PCS) shall be greater than or equal to 99.7%.

3.2.3 SPACECRAFT CONSTRAINTS ON MISSION PARAMETERS

3.2.3.1 Telemetry Constraint

There are no telemetry constraints for the spacecraft.

3.2.3.2 Thermal Attitude Constraints

a. During the coast phase on the first transfer orbit, the ICESat spacecraft requires a thermal roll of > 1˚/sec (TBR) to prevent premature solar array deployment. This thermal maneuver shall be in accordance with Table 3-12, Thermal Attitude Requirements.

b. The time between the end of the thermal roll and spacecraft separation shall not exceed 800 seconds.

3.2.4 SPACECRAFT SEPARATION REQUIREMENTS

a. The spacecraft requires a launch vehicle induced tumble about the S/C X-axis (LV Z-axis) at approximately 6.25˚/sec (TBR) to accommodate sun avoidance. Instrument field of view (IFOV) shall be greater than or equal to 30˚ half angle from the Sun.

b. Spacecraft separation requirements shall be in accordance with Table 3-13, Separation Requirements.

c. All solid byproducts due to separation ordnance device functioning shall be contained by the separation system.

3.2.4.1 Sun Angle Constraints

a. At spacecraft/launch vehicle separation the spacecraft -X axis (opposite GLAS telescope aperture) shall be pointed toward the sun (TBR).

b. The sun angle constraints during the coast phase are TBD.

3.2.5 LAUNCH OPPORTUNITY

3.2.5.1 Launch Date

The initial launch date is July 01, 2001 with a TBD launch period.

3.2.5.2 Launch Window

The time of window is being evaluated and negotiated with the other mission payload, CATSAT. Reference MDC 99H0062, CATSAT Mission Specification. The launch windows shall be in accordance with Table 3-14, Launch Times.

3.2.6 LAUNCH SITE

The launch site shall be at Delta Space Launch Complex 2 West (SLC-2W) at Vandenberg Air Force Base (VAFB).

3.2.7 LAUNCH AND FLIGHT OPERATIONS REQUIREMENTS

3.2.7.1 Operations - Prelaunch

3.2.7.1.1 Location of Spacecraft Operations Control Center

The ICESat Power Control Console (PCC), Spacecraft Test and Operations Center (STOC), and all other ICESat Ground Support Equipment (GSE) will be located in Building 1610 during spacecraft processing. After Observatory/LV mate, the PCC is relocated to the Electrical Equipment Building (EEB) for final checkout and launch, while the STOC is moved to the Launch Vehicle Data Center in Building 836.

3.2.7.1.2 Spacecraft Ground Station Interface Requirements

TBD

3.2.7.1.3 Mission-Critical Interface Requirements

TBD

3.2.7.2 Operations - Launch Through Spacecraft Separation

3.2.7.2.1 Spacecraft Uplink Requirements

There are no spacecraft uplink requirements.

3.2.7.2.2 Spacecraft Downlink Requirement

There are no spacecraft downlink requirements.

3.2.7.2.3 Launch Vehicle Tracking Stations

Major launch vehicle events will be covered by tracking stations. Expected tracking station usage includes VAFB, Malindi, Hawaii, and McMurdo.

3.2.7.2.4 Coverage by Instrumented Aircraft (IA)

If not in view of ground stations, IA coverage of all second stage restarts, DPAF separation, and spacecraft separation is required. The IA coverage will be provided by NASA.

3.2.7.3 Operations - Post-Spacecraft Separation

3.2.7.3.1 Spacecraft Tracking Station

Coverage of the spacecraft after separation will be provided by stations at Svalbard, Alaska, and Wallops.

3.2.7.3.2 Spacecraft Acquisition Assistance Requirements

a. Boeing shall provide orbital parameter messages (OPMs) for the spacecraft utilizing second stage RIFCA PCM data for the purpose of aiding spacecraft acquisition.

b. These messages shall be based on an epoch time corresponding to spacecraft separation from the second stage. Reference the Delta Mission Requirements (DMR) for other requirements including message format, epoch, means of transmittal, and point of contact.

3.3 LAUNCH VEHICLE CONFIGURATION

3.3.1 LAUNCH VEHICLE DESCRIPTION

3.3.1.1 Launch Vehicle Designation

The launch vehicle shall be a Delta II 7320-10 with a 37C Mini-Dual Payload Attach Fitting (DPAF).

3.3.1.2 Special Vehicle Insignia

The launch vehicle insignia shall be in accordance with Figure 3-8, Launch Vehicle Insignia.

3.3.2 LAUNCH VEHICLE COORDINATE SYSTEM

The launch vehicle coordinate system shall be as described in Figure 1-5, Vehicle Axes, of the Delta II Med-Lite Payload Planners Guide.

3.3.3 DUAL PAYLOAD ATTACH FITTING (DPAF) MISSION SPECIFIC CONFIGURATION

The ICESat spacecraft will be the upper payload of the Delta II DPAF. The DPAF is shown in Figure 3-9, Dual Payload Attach Fitting.

a. The DPAF shall be modified by height reduction to accommodate access to the spacecraft and the GLAS instrument.

b. The DPAF shall incorporate a contamination barrier between the upper PAF and DPAF.

3.3.4 FAIRING MISSION SPECIFIC CONFIGURATION

The launch vehicle will use a 10 foot Composite Payload Fairing.

3.3.5 SECOND STAGE MISSION SPECIFIC CONFIGURATION

3.3.5.1 Extended-Mission Modifications

Not applicable.

3.3.5.2 Retro Systems

Not applicable.

3.3.5.3 Standard Instrumentation
A telemetry system shall be installed to accommodate the standard Med-Lite fairing and DPAF instrumentation of microphone, temperature patch and pressure transducer.

3.3.5.4 Insulation
Dome foil and sidewall blankets shall be installed to keep second stage propellants within the required temperature limits (TBR).

3.3.6 FIRST STAGE MISSION SPECIFIC CONFIGURATION
TBD

3.4 SPACECRAFT AND LAUNCH VEHICLE INTERFACE REQUIREMENTS

3.4.1 RESPONSIBILITY
Responsibility for the hardware and interfaces shall be as follows:

Launch vehicle side - Boeing

Spacecraft side - NASA

3.4.2 MECHANICAL INTERFACES

3.4.2.1 Fairing

3.4.2.1.1 Access Doors and RF Windows in Fairing
Since fuel offload capability on the launch pad is required, the spacecraft will require access to the fill/drain and pressure/vent valves, as well as the test connector, on the lower deck of the spacecraft. Location of the access doors and RF window location shall be in accordance with Table 3-15, Access Doors and RF Window Location. Reference Ball Aerospace Drawing 545550.

3.4.2.1.2 External Fairing Insulation
The standard 10 foot Composite Payload Fairing insulation shall be used.

3.4.2.1.3 Acoustic Blanket for 10 Foot Composite Fairing

3.4.2.1.3.1 Cylindrical Section
Standard acoustic blankets, 3.0 inches thick, shall be used for the cylindrical section of the fairing.

3.4.2.1.3.2 Nose Cone
Standard acoustic blankets, 3.0 inches thick, are required for the nose cone section of the fairing.

3.4.2.1.3.3 Access Doors
Spacecraft access doors shall use standard 3.0 in. thick acoustic blankets.

3.4.2.1.4 Spacecraft GN2 Purge

None, except the drag on purge provided for the spacecraft by Goddard Space Flight Center (GSFC).

3.4.2.1.5 Fairing Instrumentation

The standard Med-Lite fairing instrumentation of microphone, temperature patch and pressure transducer shall be installed.

3.4.2.2 Payload Attach Fitting (PAF)

The ICESat spacecraft to launch vehicle adapter ring shall be compatible with the 37C Payload Adapter Fitting (PAF) as shown in the following figures: Figure 3-10, Payload Attach Fitting (37C); Figure 3-11, Payload Attach Fitting (37C) Separation System Interface Cross Section; and Figure 3-12, Payload Attach Fitting (37C) Flange Geometry. The spacecraft interface design is shown in Figure 3-13, Spacecraft Interface Design (TBD).

3.4.2.3 Contamination Barrier

A contamination barrier shall be between the upper PAF and the DPAF.

3.4.2.4 Separation System

3.4.2.4.1 Clampband System

a. The 37C clampband system shall be used.

b. The clampband preload shall be between 3500 lb and 4000 lbs (TBR).

c. Bulk temperature of the PAF, spacecraft and clampband during ascent shall be within 0˚ to 145˚ F (TBD).

3.4.2.4.2 Separation Springs

a. Four separation springs shall be used.

b. The individual spring force shall be 200 lbf.

3.4.3 ELECTRICAL INTERFACES

3.4.3.1 Spacecraft/Payload Attach Fitting Electrical Connectors

3.4.3.1.1 Connector Types and Locations

a. A dual 61 pin electrical umbilical from the PAF to the spacecraft shall be used.

b. The PAF/spacecraft interface connectors shall be in accordance with Table 3-16, Interface Connectors, Figure 3-14, Electrical Connector Configuration, and Figure 3-15, Electrical Connector Interface.

3.4.3.1.2 Connector Pin Assignments

The spacecraft/Payload Attach Fitting electrical connector pin assignments and associated electrical characteristics shall be as shown in Table 3-17, Pin Assignments, PAF Connector P201/A9J5A, and Table 3-18, Pin Assignments, PAF Connector P200/A9J5.

3.4.3.1.3 Spacecraft Separation Indications

Separation of the spacecraft from the DPAF shall be indicated by breakwires monitored through the spacecraft umbilical connectors. A loopback is required on each of the 61-pin connectors. Breakwire continuity will be provided on the launch vehicle side of the interface.

3.4.3.1.4 Special Spacecraft Functions

Not applicable.

3.4.3.1.5 Launch Vehicle to Spacecraft Discretes

Not applicable.

3.4.3.2 Separation Switches

Not applicable.

3.4.4 SPACECRAFT ENVIRONMENTS

3.4.4.1 Steady-State Acceleration

The maximum spacecraft axial acceleration shall be 7.9g occurring just prior to main engine cutoff (MECO).

3.4.4.2 Structural Loads

ICESat spacecraft preliminary design load factors shall be in accordance with Table 3-19, Structural Loads.

3.4.4.3 Dynamic Environments

3.4.4.3.1 Acoustic Environments

The maximum acoustic environment levels shall be as shown in Figure 3-16, Spacecraft Acoustic Environment Maximum Flight Levels.

3.4.4.3.2 Vibration

The maximum flight vibration levels on the spacecraft shall be in accordance with Table 3-20, Maximum Flight Sinusoidal Vibration Levels.

3.4.4.3.3 Spacecraft Interface Shock Environment

a. The spacecraft interface shock environment is based upon a maximum clampband preload of 5,700 lbs.

b. The maximum flight shock levels on the spacecraft shall be in accordance with Figure 3-17, Maximum Flight Spacecraft Interface Shock Environment - 37C.

3.4.4.4 Thermal Environment

3.4.4.4.1 Fairing Temperature and Emissivities

Inner wall temperature and emittance are shown in Figure 3-18, Ascent Thermal Environment. The acoustic blanket surface temperatures prior to liftoff will track the PLF air-conditioning temperature.

3.4.4.4.2 Free Molecular Heating Rate

The theoretical free molecular heating rate (for a flat plate normal to the free stream and based on the 1962 US standard atmosphere) at fairing separation shall not exceed 0.07 btu/ft^2-sec.

3.4.4.5 RF Environment

a. The RF environment at SLC-2W caused by the launch vehicle and masked radars that are under Range control shall be in accordance with Table 3-21, Radio Frequency Environment at SLC-2W.

a. The RF environment requirements during spacecraft ground transport shall be identified in the spacecraft Program Requirements Document (PRD).

3.4.4.6 Electrical Bonding

The spacecraft-to-launch vehicle electrical bonding shall have a resistance of <2.5 milliohms across the separation plane.

3.5 SPACECRAFT GROUND HANDLING AND PROCESSING REQUIREMENTS

3.5.1 TEMPERATURE AND HUMIDITY

The spacecraft environment shall be in accordance with Table 3-22, Ground Handling Environmental Requirements.

3.5.2 AIR CONDITIONING AND GN2 PURGES

3.5.2.1 Air Conditioning

a. The payload fairing shall incorporate a standard air conditioning diffuser.
b. The fairing airflow shall be 1500 scfm (maximum allowable).

3.5.2.2 GN2 Purge

a. The spacecraft shall provide a GN2 drag-on purge of the spacecraft.
b. The purge shall be disconnected during PLF close-out (approximately L-14 hrs).

3.5.3 CONTAMINATION

3.5.3.1 Cleanliness Category

a. When the spacecraft is inside the Mobile Service Tower (MST) environmental shroud, the air flow shall be maintained at a Class 10,000 or better in accordance with Table 3-22.

b. From PLF encapsulation through liftoff, fairing air flow shall be maintained at a Class 10,000 or better in accordance with Table 3-22.

3.5.3.2 Spacecraft Environmental Shroud

The spacecraft environmental shroud shall maintain the environment in accordance with Table 3-22.

3.5.3.3 Contamination Control Plan

The fairing/DPAF shall be cleaned and inspected per Boeing STP 0407-03 (meeting intent of MIL-STD-1246C Level 750A).

3.5.4 SPACECRAFT BALANCING AND WEIGHING

3.5.4.1 Spacecraft Balancing

Spin balance of the spacecraft is not required.

3.5.4.2 Spacecraft Weighing

A standard Boeing procedure shall be used to certify the spacecraft weight to within +/- 0.1% prior to mating at the launch site.

3.5.5 FACILITY SECURITY

The facility shall provide access control with escort and non-escort badges for SLC-2W and the RLCC (TBD). The program is unclassified.

3.5.6 SPECIAL HANDLING REQUIREMENTS

TBD

3.5.6.1 In Payload Processing Facility

The spacecraft-provided lifting ground support equipment (in Building 1610) for DPAF operations shall accommodate the spacecraft and a payload attach fitting of 130 lbs.

3.5.6.2 During Transport

TBD

3.5.6.3 On Stand

Boeing shall provide the ICESat program with available mechanical ground support equipment (MGSE) required for access to the spacecraft while stacked at SLC-2W. This MGSE will be used by ICESat personnel to complete final spacecraft closeout, fuel off-load operations (as required), and any other touch work on the pad.

3.5.7 SPECIAL BOEING-SUPPLIED EQUIPMENT AND FACILITIES

TBD

3.5.8 RANGE SAFETY CONSOLE INTERFACE

None.

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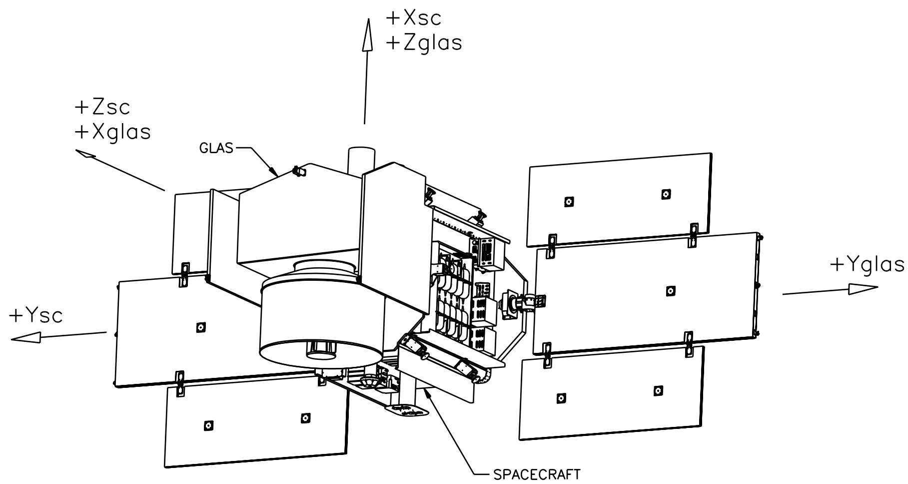

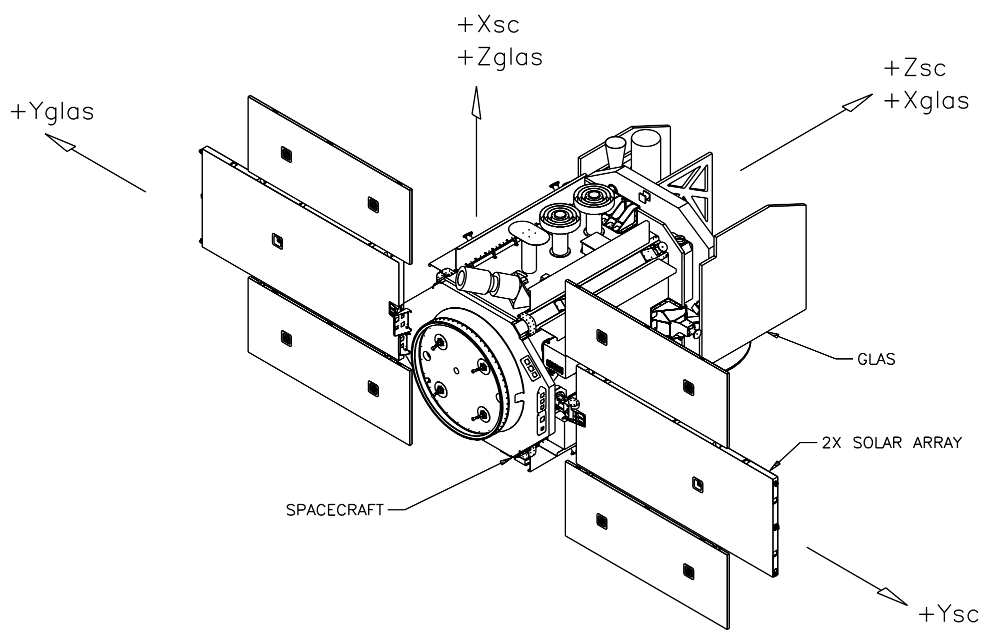

Figure 3-1 Spacecraft On-Orbit Configuration

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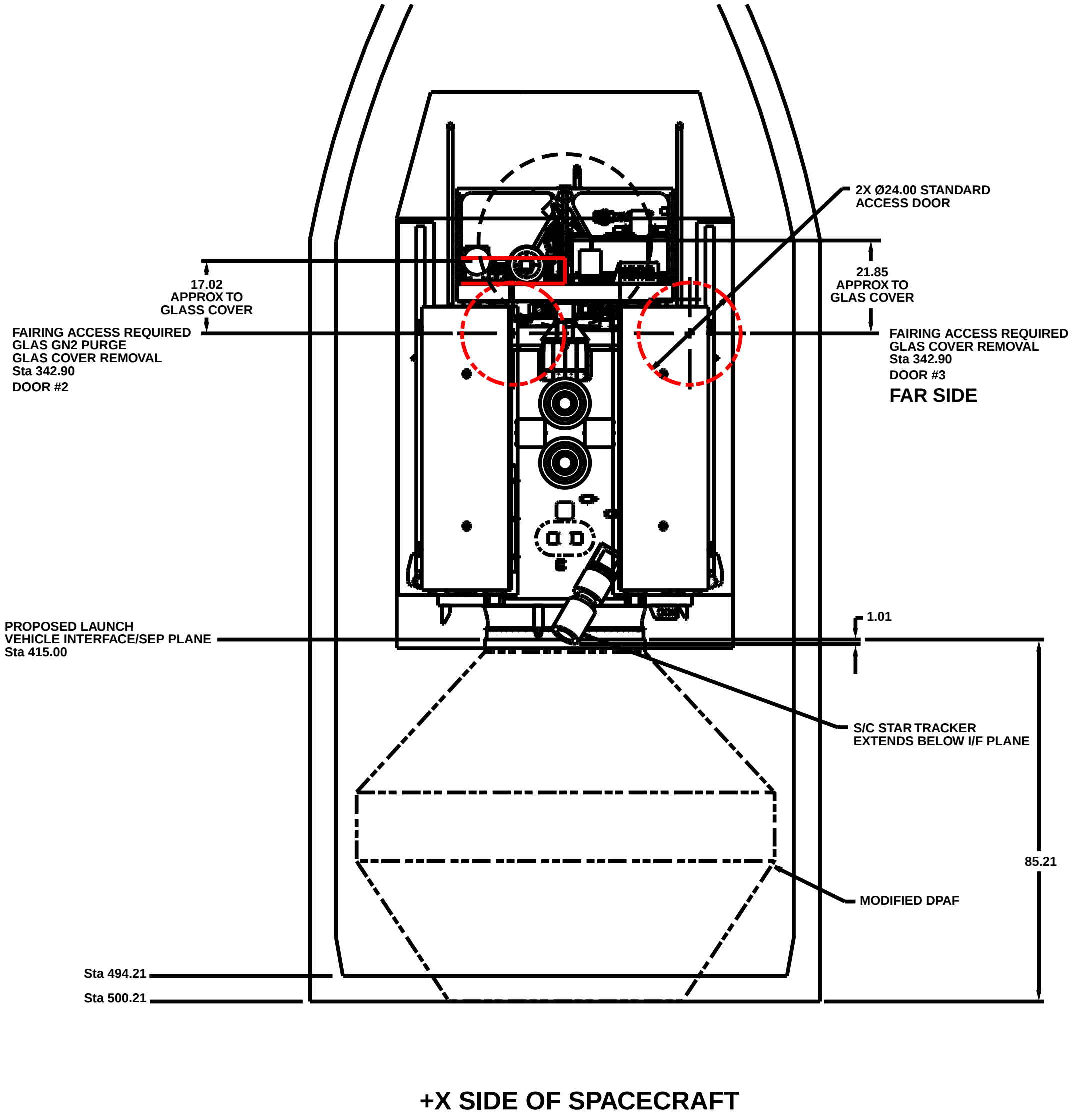


Figure 3-2 Spacecraft Launch Configuration

F00340b

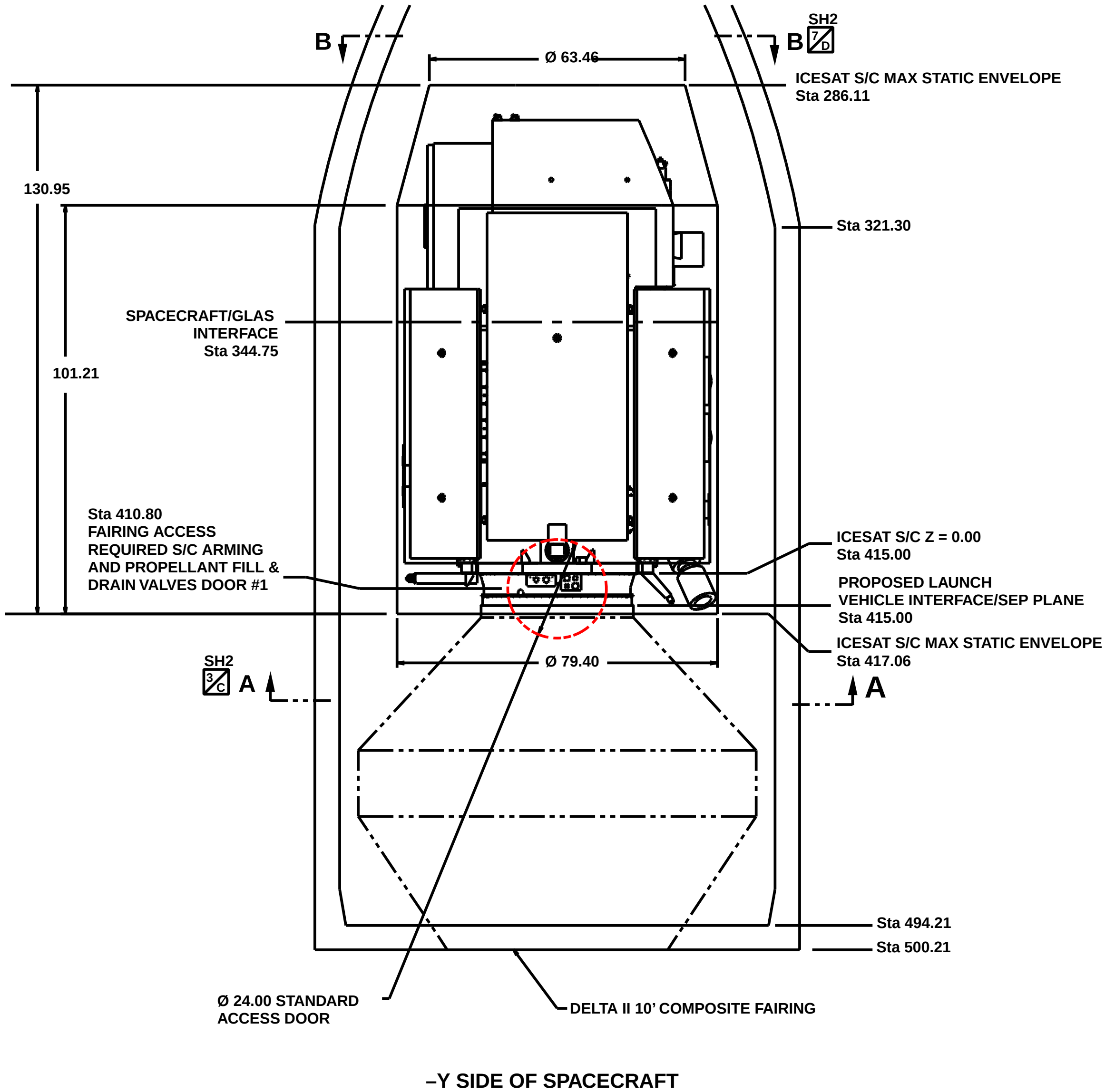


Figure 3-3 Spacecraft Launch Configuration (continued)

F00366a

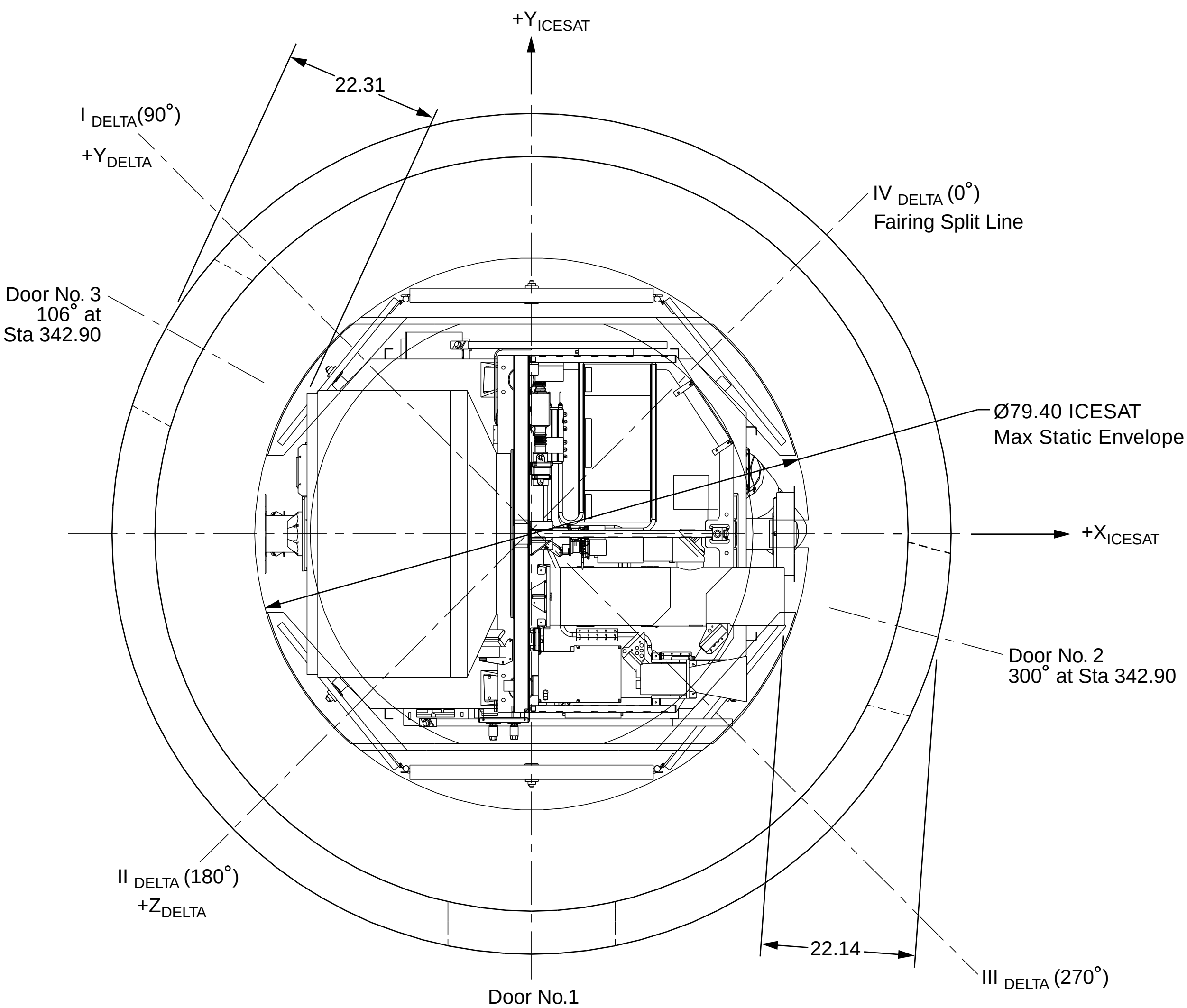


Figure 3-4 Spacecraft and Launch Vehicle Coordinate System

F00366b

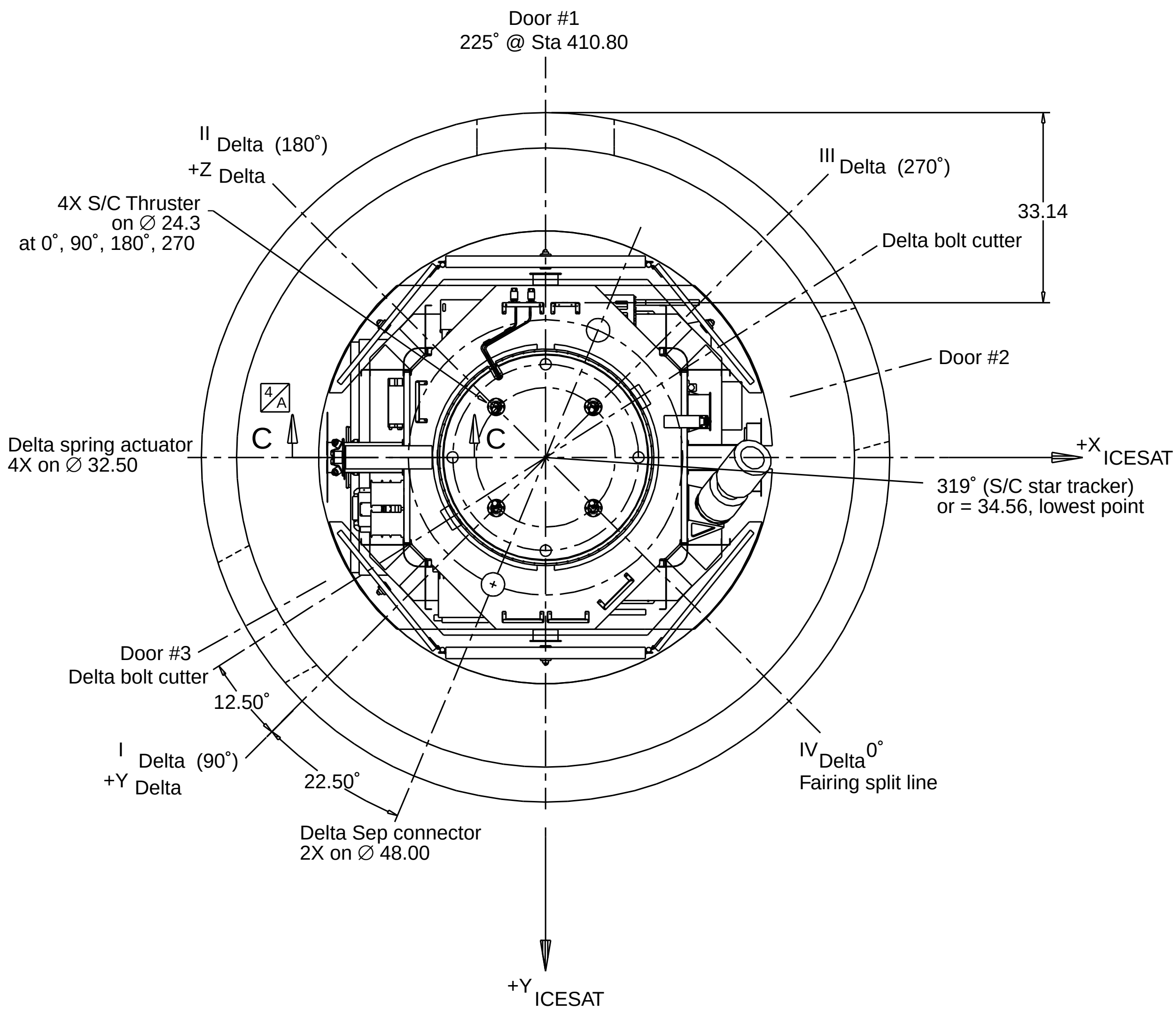
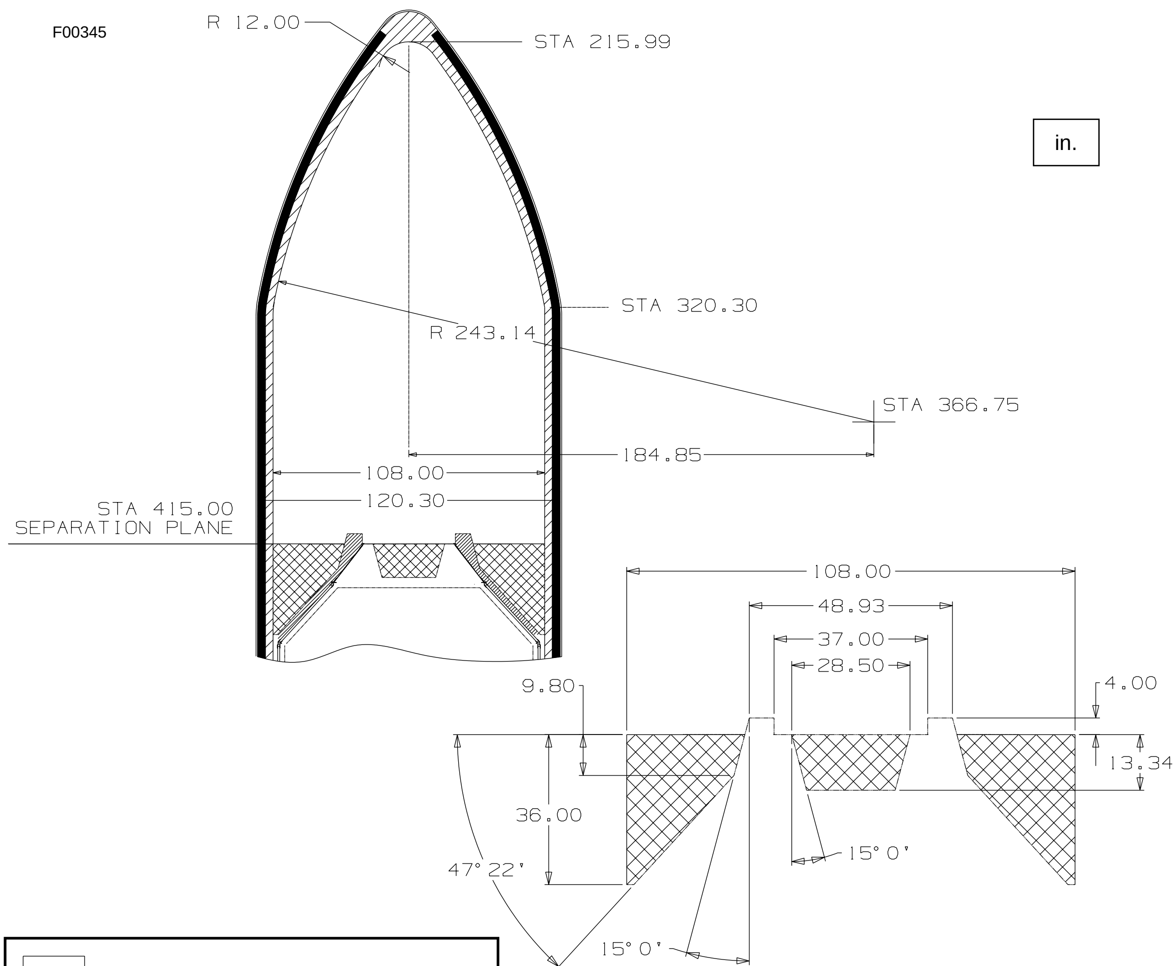


Figure 3-5 Spacecraft and Launch Vehicle Coordinate System (continued)

F00345



USABLE PAYLOAD ENVELOPE
FAIRING ENVELOPE
USABLE AREA BELOW SEPARATION PLANE
ACOUSTIC BLANKETS

All dimensions are in inches

All station numbers are in inches.

Boeing requires definition of spacecraft features within 2.00 inches of payload envelope.

Projections of spacecraft appendages below the spacecraft separation plane may be permitted, but must be coordinated with the Delta Program Office.

Figure 3-6 Payload Fairing Envelope

F00422

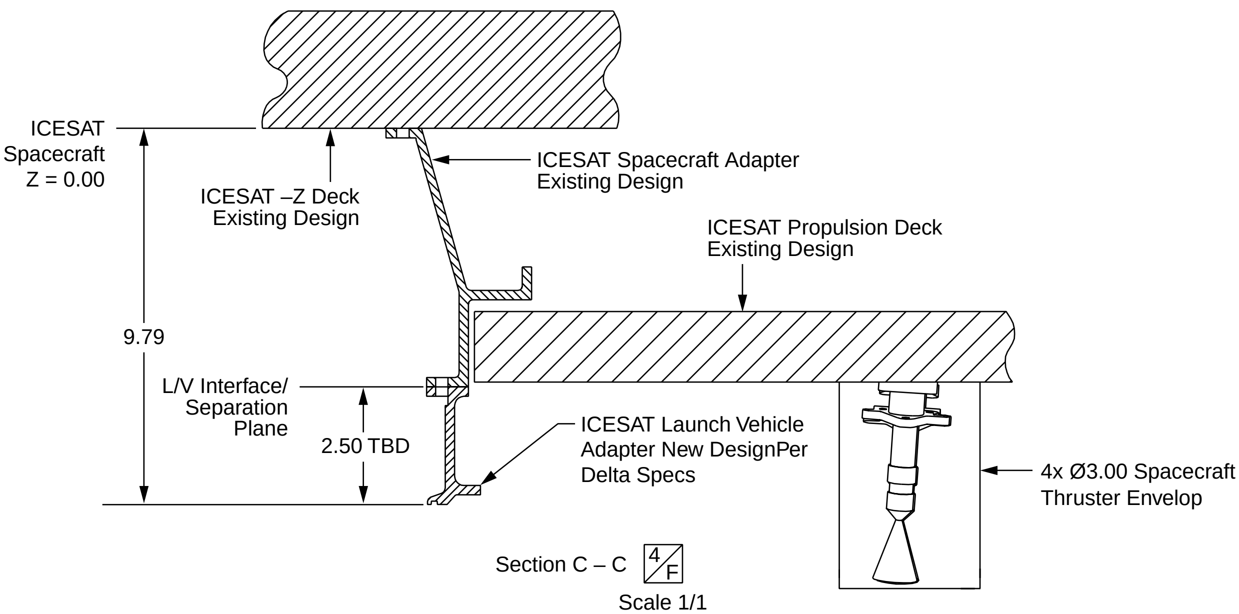


Figure 3-7 Spacecraft/LV Separation Plane Interfaces (TBD)

F00343

TBD

Figure 3-8 Launch Vehicle Insignia (TBD)

F00373

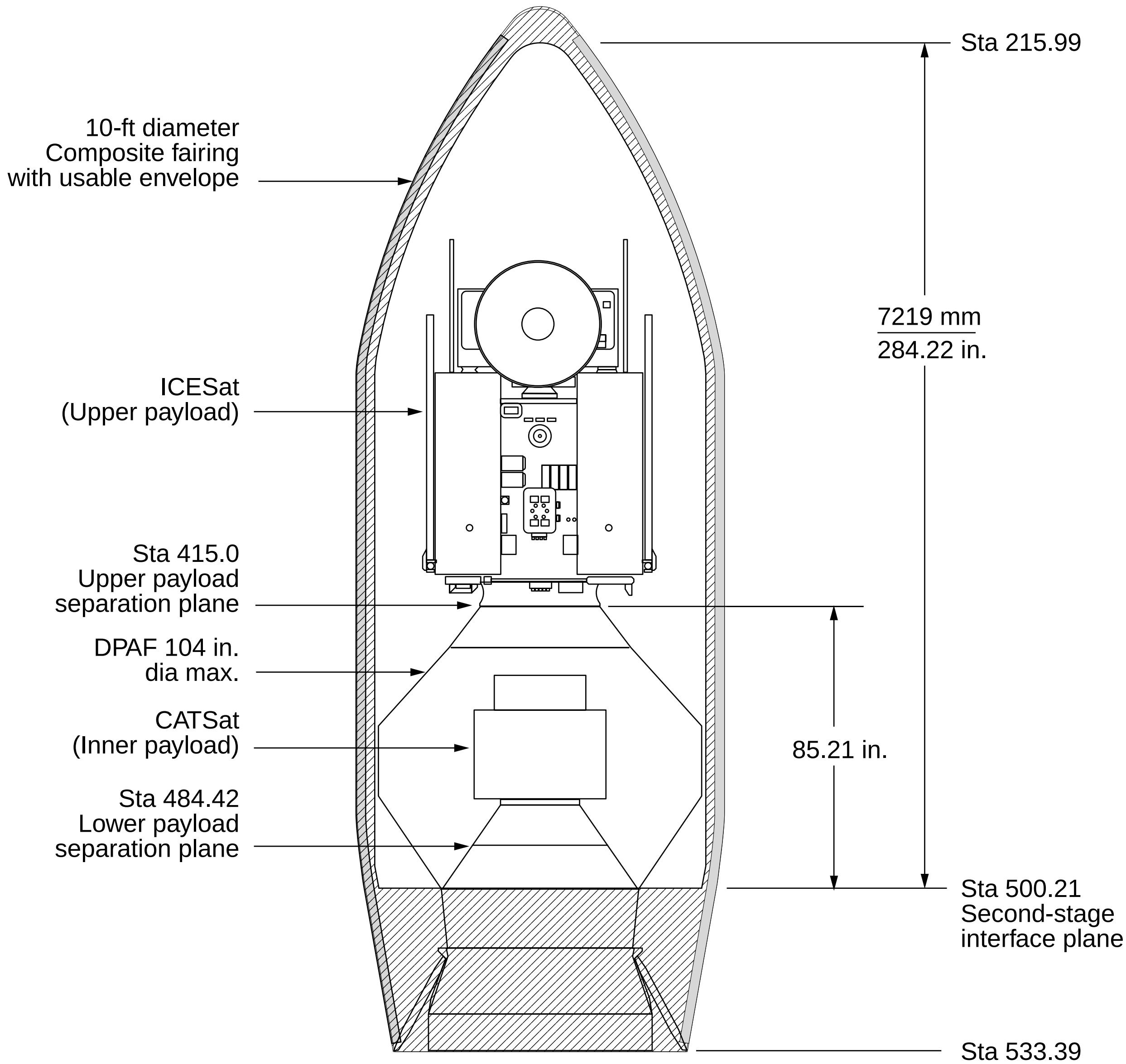


Figure 3-9 Dual Payload Attach Fitting

F00344

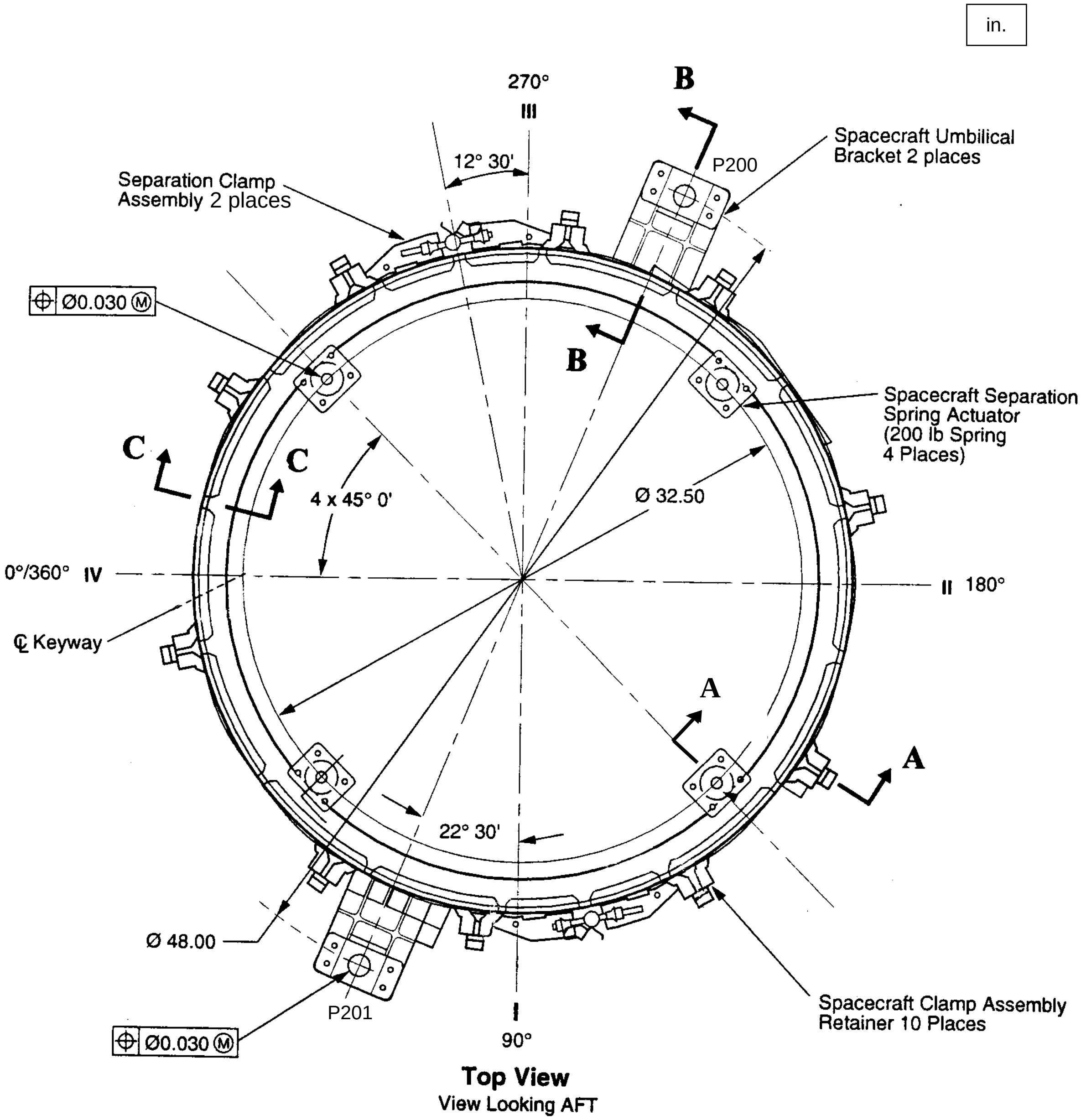
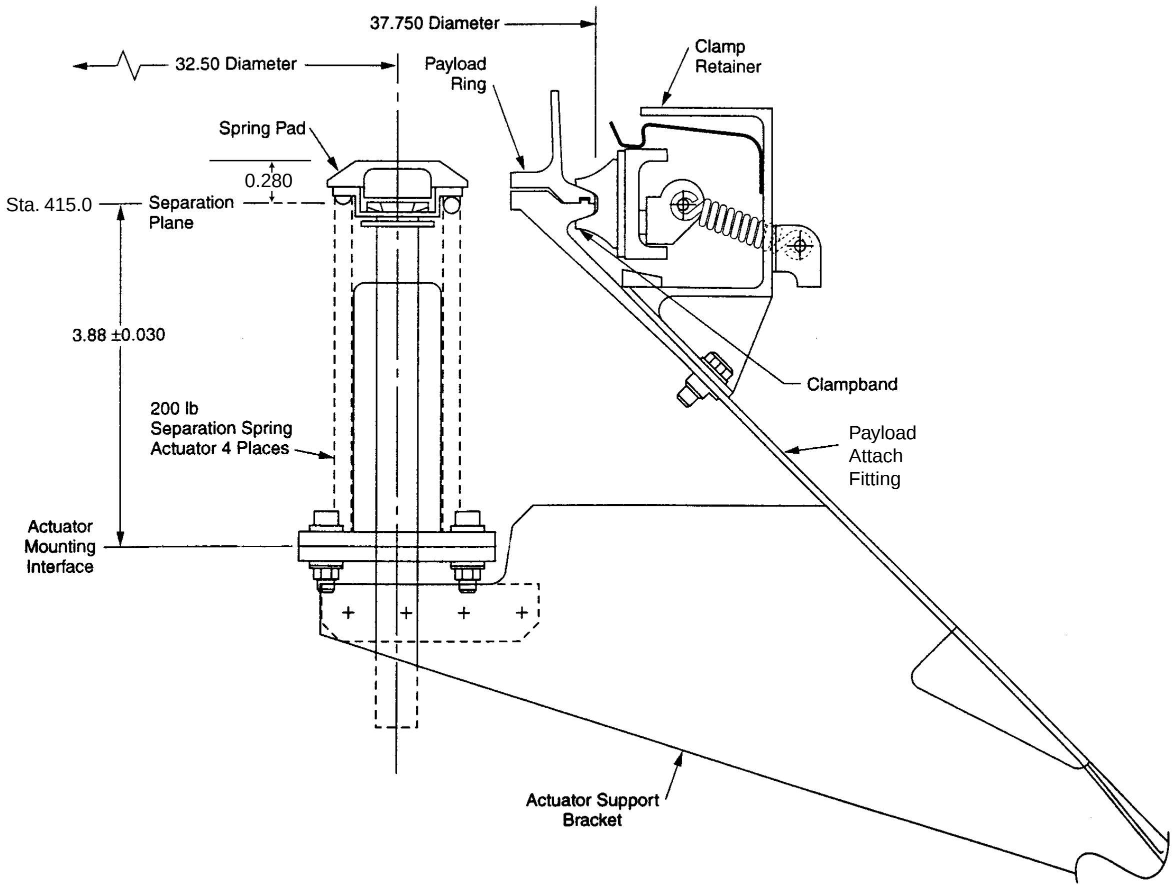


Figure 3-10 Payload Attach Fitting (37C)

F00369

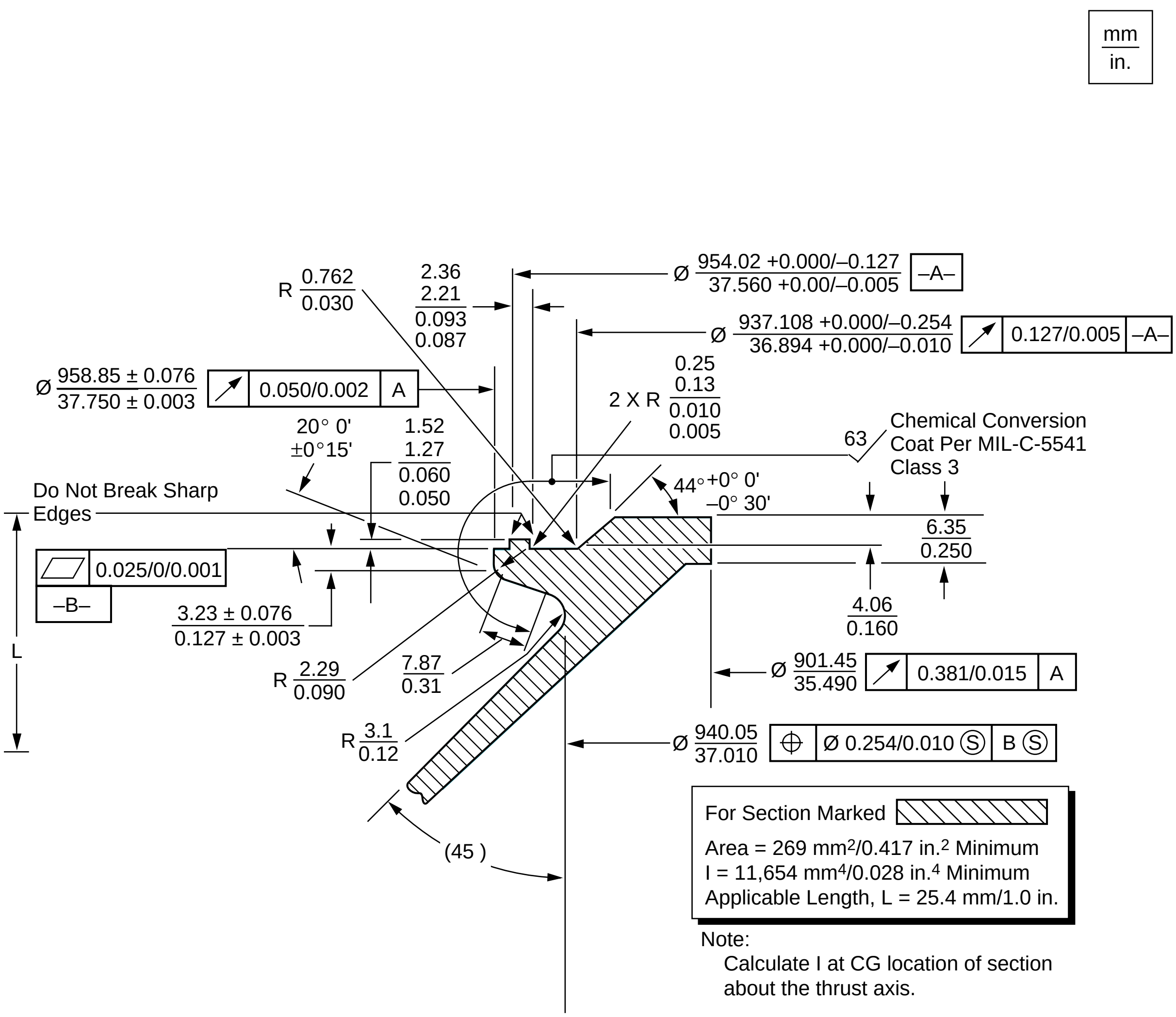
in.



Section A-A from payload attach fitting (37C)
rotated 45˚ counter clock wise

Figure 3-11 Payload Attach Fitting (37C) Separation System Interface Cross Section

F00372



View C-C
From Payload Attach Fitting 37C
Rotated 15˚ Counter Clockwise

Figure 3-12 Payload Attach Fitting (37C) Flange Geometry

F00385

TBD

Figure 3-13 Spacecraft Interface Design (TBD)

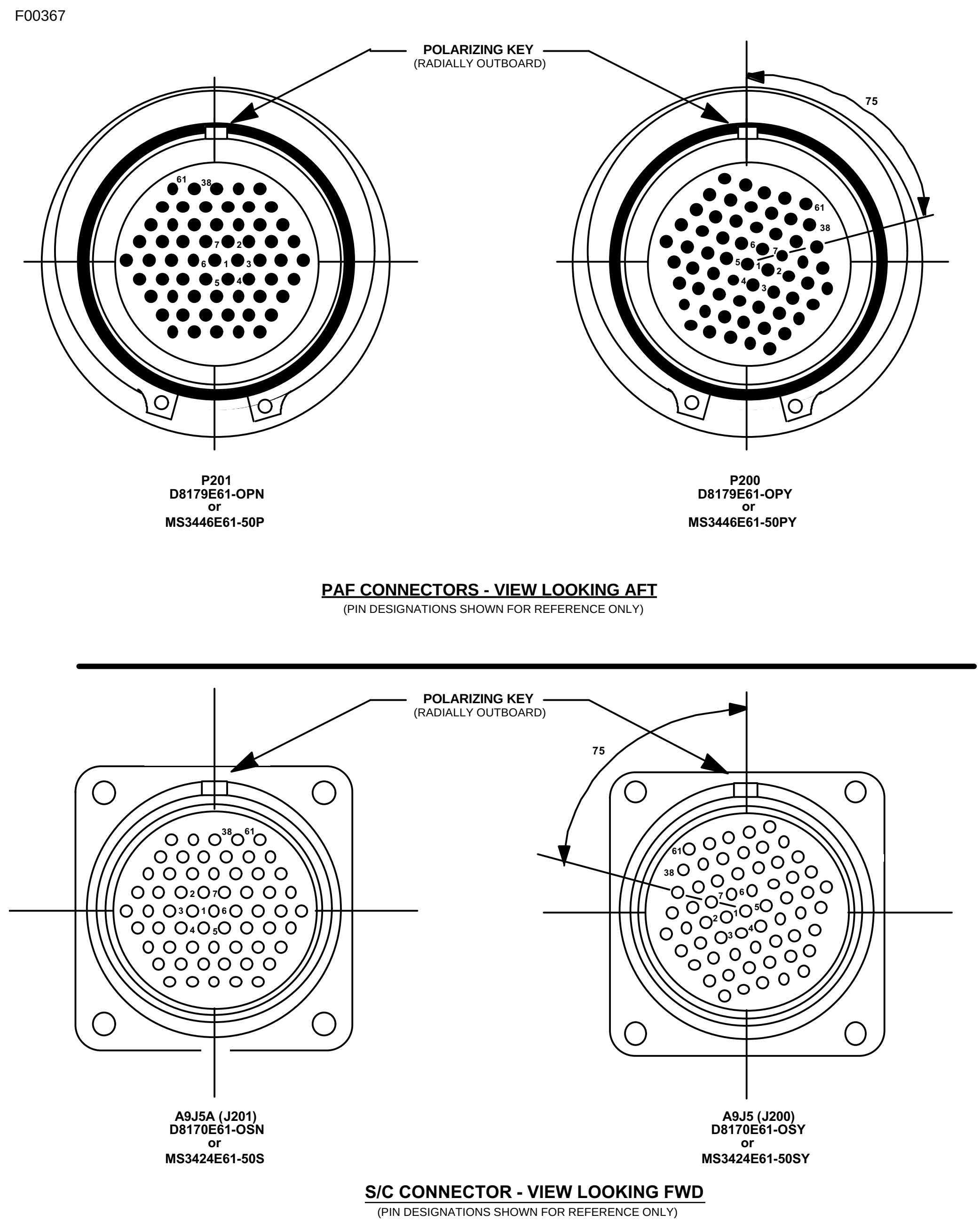
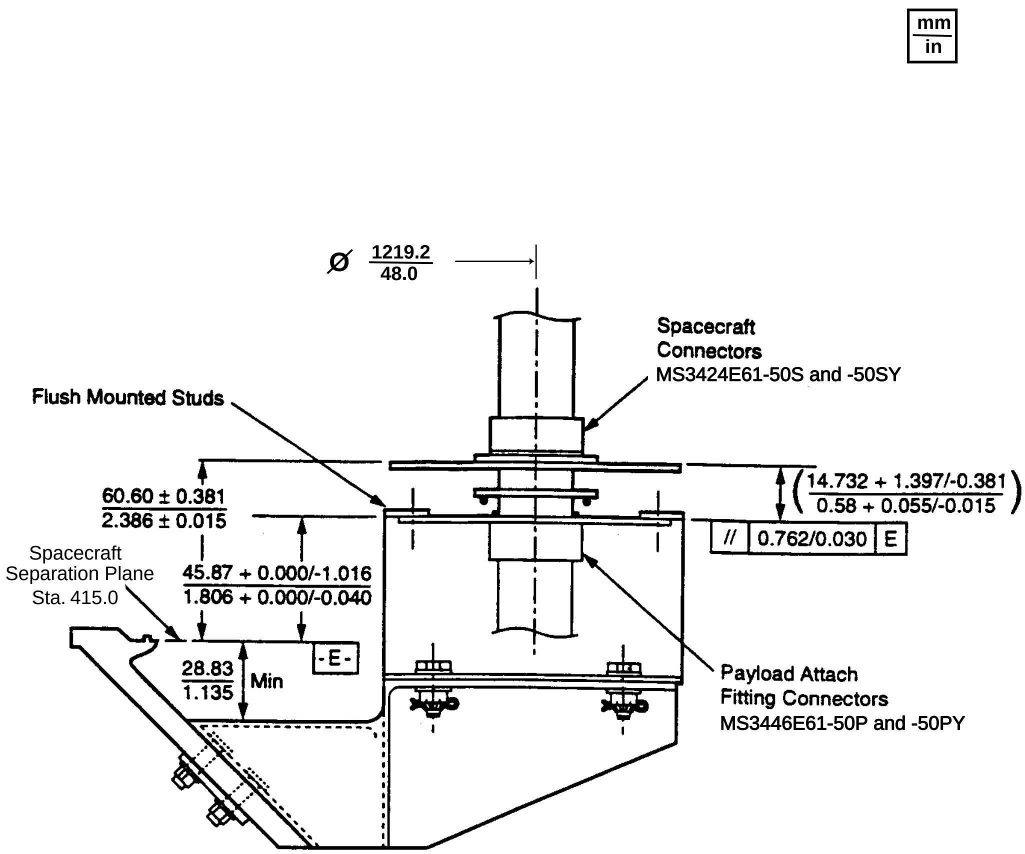


Figure 3-14 Electrical Connector Configuration

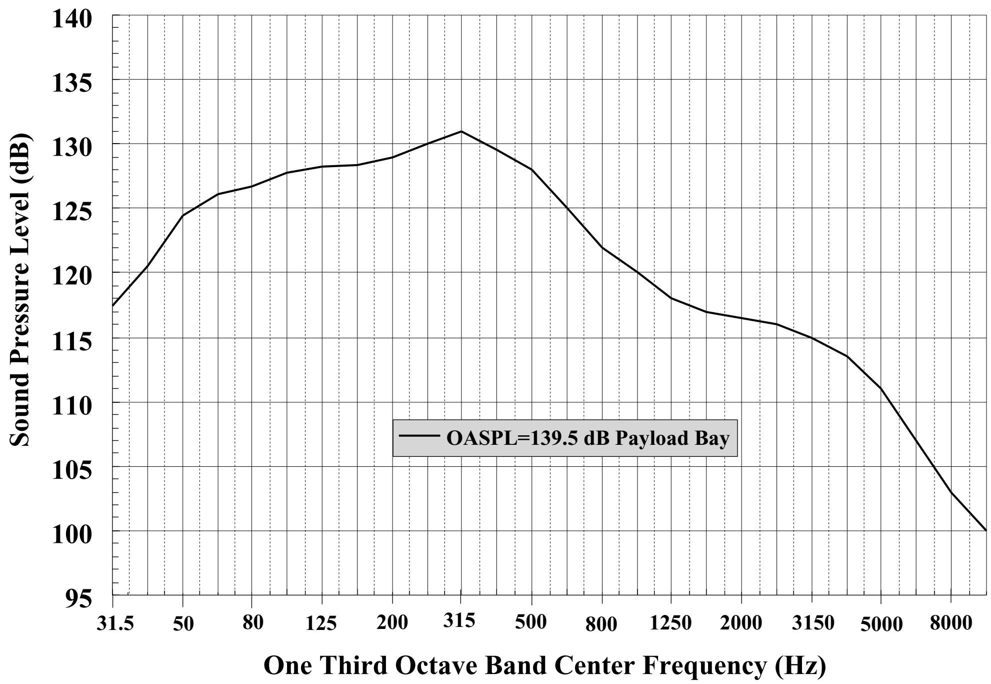
F00371



Section B-B from payload attach fitting (37C)
rotated 67° 37' clock wise

Figure 3-15 Electrical Connector Interface

F00348



One-Third Octave Band Center Frequency (Hz)	Maximum Flight Sound Pressure Levels 95th Percentile Space Average (dB)
31.5	117.4
40	120.5
50	124.5
63	126.1
80	126.7
100	127.8
125	128.3
160	128.4
200	129
250	130
315	131
400	129.5
500	128
630	125
800	122
1000	120
1250	118
1600	117
2000	116.5
2500	116
3150	115
4000	113.5
5000	111
6300	107
8000	103
10000	100
OASPL	139.5
DURATION	5 SECONDS

dB Ref: 20 micro Pa

Figure 3-16 Spacecraft Acoustic Environment Maximum Flight Levels

F00377

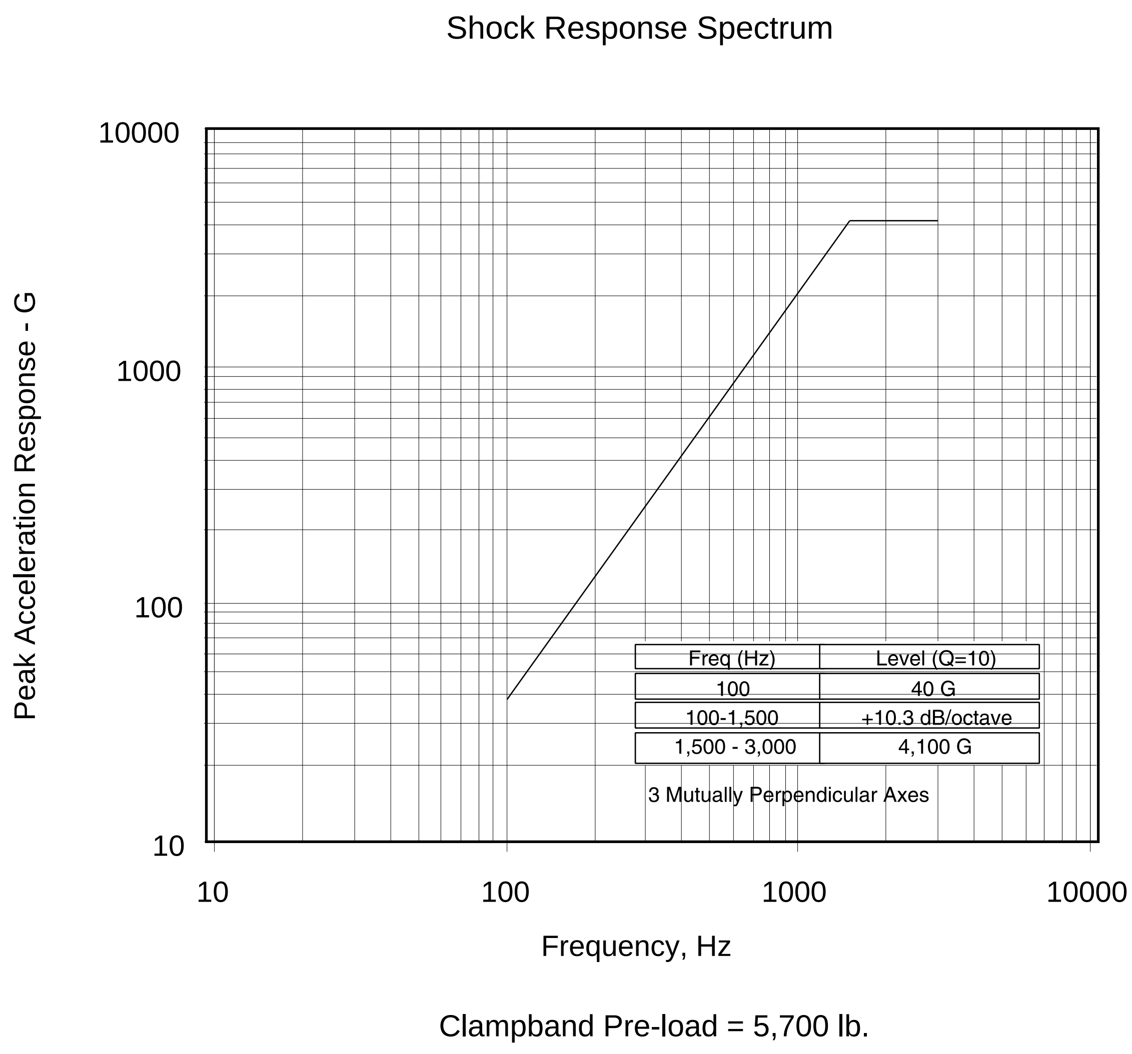


Figure 3-17 Maximum Flight Spacecraft Interface Shock Environment - 37C

F00349

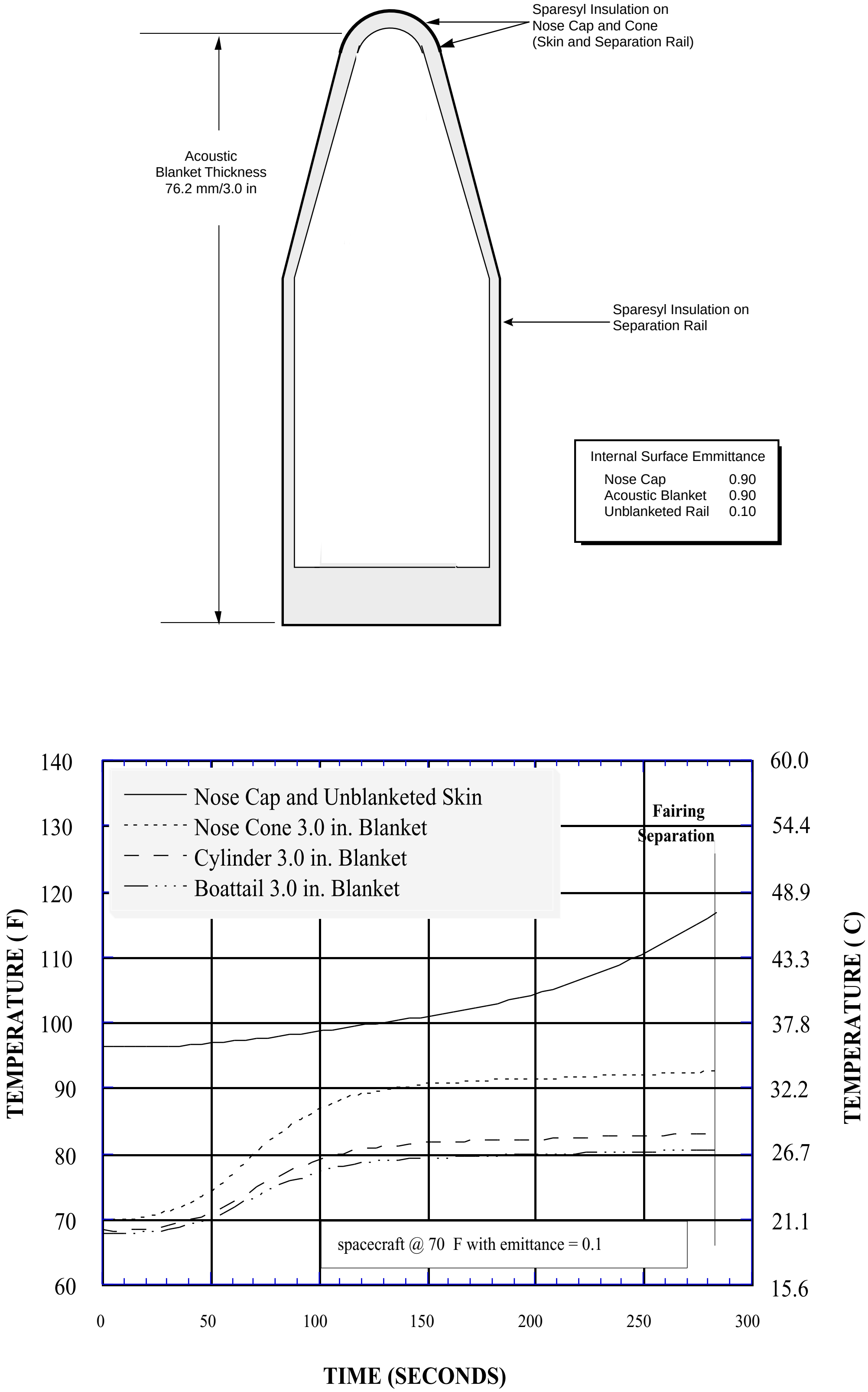


Figure 3-18 Ascent Thermal Environment

Table 3-1 Spacecraft Weight, MOI, POI, and CG Location (TBR)

Description	Axis[1]	Value	+/- 3σ Uncertainty
Weight (kg/lb)	-	1020.0/2248.7 (TBR)	+/- 10/22 (TBR)
Center of Gravity (mm/inches)	X	22.86/0.900 (TBR)	+/- 50.8/2 (TBR)
	Y	-6.680/-0.263 (TBR)	+/- 50.8/2 (TBR)
	Z[2]	1065.1/41.932 (TBR)	+/- 101.6/4.0 (TBR)
Moments of Inertia[3] (kg-m^2)	I_{XX}	714.4 (TBR)	+/- 140 (TBR)
	I_{YY}	699.1 (TBR)	+/- 140 (TBR)
	I_{ZZ}	252.6 (TBR)	+/- 51 (TBR)
Products of Inertia[3], [4] (kg-m^2)	I_{XY}	1.8 (TBR)	+/- 10 (TBR)
	I_{YZ}	5.3 (TBR)	+/- 10 (TBR)
	I_{ZX}	45.4 (TBR)	+/- 46 (TBR)

Notes:

(1) Spacecraft Coordinate System.

(2) Z-axis 0 point is approximately 8 in (TBR) above Observatory/LV separation interface plane.

(3) Moments and products of inertia based on a spacecraft weight of 991.43 kg (2185.73 lbs).

(4) Products of inertia defined as positive integrals.

T00308

Table 3-2 Violations in the Fairing Envelope (TBD)

Item	LV Vertical Station (inches)	Radial Dimension (inches)	Clocking from Spacecraft X-axis	Clocking from LV Quad IV Axis	Clearance from stay out zone
TBD	TBD	TBD	TBD	TBD	TBD

T00327

Table 3-3 Violations in the Separation Plane Envelope (TBD)

Item	LV Vertical Station (inches)	Radial Dimension (inches)	Clocking from Spacecraft X-axis	Clocking from LV Quad IV Axis	Clearance from stay out zone
Star Tracker	TBD	TBD	TBD	TBD	TBD
Sun Sensor	TBD	TBD	TBD	TBD	TBD
Thruster	TBD	TBD	TBD	TBD	TBD
Thruster	TBD	TBD	TBD	TBD	TBD
Thruster	TBD	TBD	TBD	TBD	TBD
Thruster	TBD	TBD	TBD	TBD	TBD

T00328

Table 3-4 Propellant Tank Characteristics (TBD)

Parameter	Value
Propellant Type	Ultra-pure Hydrazine
Propellant Weight, Nominal	76 kg
Propellant Fill Fraction	83%, 721 in^3 GN2 as pressurant
Propellant Density	62.93 lbm/ft^3 at a temperature of 68° F
Propellant Tanks	1
Propellant Tank Location (SC coordinates) Station Azimuth Radius	TBD
Internal Volume	5555 in^3
Capacity	78.7 kg
Diameter	22 inches (55.9 cm)
Shape	sphere
Internal Description	Titanium Pressure Vessel, APE Diaphragm
Operating Pressure - Flight	420 psia maximum
Operating Pressure - Ground	420 psia maximum
Design Burst Pressure - Calculated	1094 psia
FS (Design Burst/Ground MEOP)	2.6
Actual Burst Pressure - Test	1280 psig
Proof Pressure - Test	800 psig
Vessel Contents	Hydrazine, GN2 (separated by a diaphragm)
Capacity - Launch	78.7 kg
Quantity - Launch	76 kg
Purpose	Spacecraft Propulsion
Pressurized at	Hazardous Processing Facility
Pressure when Boeing personnel are exposed	Yes - to 420 psia
Tank Material	Titanium
Number of vessels used	1

T00310

Table 3-5 Spacecraft Battery

Parameter	Value
Battery Type	NiH2
Electrolyte	KOH
Battery Capacity	40 A-hr
Number of Cells	24[(1)]
Average Voltage/Cell	1.4 V
Cell Pressure (Ground MEOP)	900 psi
Specification Burst Pressure	2300 psi
Actual Burst	3515 psi
Proof Tested	1690 psi
Cell Pressure Vessel Material	Inconel 718

Note:

(1) 12 Common Pressure Vessels (CPVs)

T00313

Table 3-6 RF Transmitter and Receiver Characteristics (TBR/TBD)

Parameter	Antennas		
	X-Band/T	**S-Band/T**	**S-Band/R**
Nominal Frequency (MHz)	8100	2215	2039.65
Transmitter Tuned Frequency (MHz)	8100	2215	N/A
Receiver Frequency (MHz)	N/A	N/A	2039.65
Data Rates, Downlink (kbps)	40000	Carrier 262.144 Subcarrier 16.384	TBD
Symbol Rates, Downlink (kbps)	40000	Carrier 529.288, subcarrier 32.768	2 (TBR)
Type of transmitter	SQPSK	PM/PSK/BPSK	TBD
Transmitter Power, Maximum (dBm)	9.8dBW (9.5W)	9.0 dBW (8W)	N/A
Losses, minimum (dB)	0.5	1.5	N/A
Peak Antenna Gain (dB)	6.0 dBi	6.0 dBi	3.5 dBi
EIRP, Maximum (dBm)	15.3 dBWi	13.5 dBWi	N/A
Antenna Location (base)	Microstrip patch RHCP, nadir facing	Microstrip patch antenna LHCP, nadir/zenith facing	Omni coupled Microstrip patches LHCP, nadir/zenith facing
Antenna Station (in) Zenith Nadir	 N/A 385.6	 391.2 386.6, 379.1	 391.2 379.1
Angular location	Spacecraft -X axis (nadir)	Spacecraft -X axis (nadir) Spacecraft +X axis (zenith)	Spacecraft X axis (nadir) Spacecraft +X axis (zenith)
Planned Operation: Prelaunch: In building 1610 Prelaunch: Pre-Fairing Installation Postlaunch: Before Spacecraft Separation	 Yes, Radiating No No, Not Powered	 Yes, Radiating No No, Not Powered	 Yes Yes Powered
Distance where RF Level = 10 mW/cm2	0.2 m	0.5 m	N/A

T00314

Table 3-7 Non-EED Release Devices

Qty	Type	Use	Qty Explosives	Type	Explosives	Where Installed	Where Connected	Where Armed
10	Shaped Memory Alloy, Frangible-Bolt, Release Mechanism	Solar Panel Retention and Release	0	Shaped Memory Alloy, Frangible-Bolt, Release Mechanism	Not Applicable, non-explosive	Boulder, CO at BATC facility, shipped installed	Boulder, CO	Bldg 1610 after Arm Plug Installed

T00315

Table 3-8 Contamination Sensitive Surfaces (TBD)

Component	Sensitive to	NVR	Particulate	Level
Laser (GLAS)	Surface Contamination	A[(1)] 0.1 $\mu g/cm^2$		10K, w/ 1K handling procedure
Optics (GLAS)	Surface Contamination	A[(1)] 1.0 $\mu g/cm^2$		10K, w/ 1K handling procedure
Star Tracker (spacecraft)	Surface Contamination	C[(2)] 3 $\mu g/cm^2$	500C[(3)]	10K, w/ 1K handling procedure
Optical Solar Reflector radiator surfaces	Surface Contamination	C[(2)] 3 $\mu g/cm^2$	500C[(3)]	TBD
Sun Sensor	Surface Contamination	TBD	TBD	TBD
Telescope	Surface Contamination	A[(1)]		10K, w/ 1K handling procedure
Solar Arrays	TBD	TBD	TBD	TBD

Notes:

(1) A = TBD

(2) C = TBD

(3) 500C = TBD

T00316

Table 3-9 Spacecraft Systems Activation

Event	Time from liftoff	Constraints/Comments
Essential Bus will be on: Power Control Unit S-band receivers Support Electronics Package Emergency Mode Controller Command Decoder Unit GLAS Survival Heaters Propulsion Module Heaters Bus Survival Heaters Solar Array Drive Heaters	L-14 hours	Battery arm plug installation

Note:

- All heaters are enabled and thermostatically controlled.

T00317

Table 3-10 Orbit Characteristics (TBR)

Osculating Orbit Parameter at SECO 2	Value
Apogee	590 km (TBR)
Perigee	590 km (TBR)
Inclination	94° (TBR)
Argument of Perigee at Insertion	90° (TBR)

T00318

Table 3-11 Orbit Dispersion Requirements (TBR)

Orbit Characteristic	Error	Value
Apogee Radius	3σ	+/- 10 km (TBR)
Perigee Radius	3σ	+/- 10 km (TBR)
Inclination	3σ	+/- 0.03° (TBR)

T00348

Table 3-12 Thermal Attitude Requirements (TBD,TBR)

Parameter	Value
Rotation axis	Launch Vehicle X-axis, spacecraft Z-axis
Rotation rate	>1°/sec (TBR)
Rotation axis position in space	TBD

T00349

Table 3-13 Separation Requirements (TBR)

Parameter	Value
Attitude	TBR +/- TBR
Tip Off Angular Rate [1]	
X	6.25 +/- 1.25 deg/sec (TBR)
Y	0 +/- 2.5 deg/sec (TBR)
Z	0 +/- 1.0 deg/sec (TBR)

Note: (1) Spacecraft coordinate system.

T00319

Table 3-14 Launch Times (TBD)

Window Open mm/dd/yy hh:mm:ss	Window Close mm/dd/yy hh:mm:ss	Window Open mm/dd/yy hh:mm:ss	Window Close mm/dd/yy hh:mm:ss

T00324

Table 3-15 Access Doors and RF Window Location

Size (inches)	LV Station (inches)(1)	Clocking (degrees)(2)	Purpose
24	410.80	225	Fill/ Drain and Arm Plug Installation
24	342.90	106	GLAS Cover Removal
24	342.90	300	GLAS Cover Removal

Notes:

(1) Doors are centered at the locations specified

(2) Clocking is measured from Quad IV ($0/360^{o}$) toward Quad I (90^{o})

T00322

Table 3-16 Interface Connectors

Item	P201	P200
Vehicle Connector	MS3446E61-50P	MS3446E61-50PY
Spacecraft Mating Connectors (A9J5A and A9J5)	MS3424E61-50S	MS3424E61-50SY
Distance Forward of Spacecraft Mating Plane	2.386 – 0.015 in	2.386 – 0.015 in
Launch Vehicle Station	412.614 – 0.015 in	412.614 – 0.015 in
Azimuth	22 deg 30 min Quad I to IV	22 deg 30 min Quad III to II
Radial Distance of Connector Centerline from Vehicle Centerline	24.00 in	24.00 in
Polarizing Key	radially outboard	radially outboard
Maximum Connector Force (+Compression, -Tension)	+49 /-68 lbs	+49/-68 lbs

Note:

- Positional tolerances defined in Delta II Med-Lite Payload Planners Guide

T00320

Table 3-17 Pin Assignments, PAF Connector P201/A9J5A (TBD)

Pin No.	Twisted and Shielded with[1]	Function	Volts	Amps	Max resistance To EEB (ohms)	Polarity Requirements
1		BATT V MON	+30+/-5	0.001	100	
2		BAPS ON	+30+/-5	0.2	10	
3		BAPS OFF	+30+/-5	0.2	10	
4		BAPS RTN	0+/-1	0.2	10	
5		BATT CHARGE (+)	+30+/-5	2	1	
6		BATT CHARGE (+)	+30+/-5	2	1	
7		BUS V MON	+30+/-5	0.001	100	
8		SMB STATUS	+30+/-5	0.001	100	
9		PLB STATUS	+30+/-5	0.001	100	
10		NEB STATUS	+30+/-5	0.001	100	
11		HZB STATUS	+30+/-5	0.001	100	
12		HZB1 ARM STATUS	+30+/-5	0.003	100	
13		HZB2 ARM STATUS	+30+/-5	0.003	100	
14		~~EMC ENABLE STATUS~~				
15	16*	DELTA SEP2 (+)				
16	15*	DELTA SEP2 (-)				
17		SPARE				
18		LV1 STATUS	+30+/-5	0.002	100	
19		LV2 STATUS	+30+/-5	0.002	100	
20		SCC CONFIG LATCH #8	+3+/-2	0.001	100	
21		SCC CONFIG LATCH #9	+3+/-2	0.001	100	
22		SIGNAL RTN	0+/-1	0.001	10	
23		SCC1 SEPARATION IND (-)				
24		SCC1 SEPARATION IND (+)				
25		SIGNAL RTN	0+/-1	0.001	10	
26		CTU GSE DECACT A%	+3+/-2	0.001	100	
27		CTU GSE DECACT B%	+3+/-2	0.001	100	
28		CTU GSE SEL CDUAP	+3+/-2	0.001	100	
29		CTU GSE SEL CDUBP	+3+/-2	0.001	100	
30		SEPARATED2 (+) BOEING				
31		SEPARATED2 (-) BOEING				
32	33*	CTU GSE S DATA (+)	+3+/-2	0.005	100	
33	32*	CTU GSE S DATA (-)	+3+/-2	0.005	100	
34	35*	CTU GSE 1 DATA (+)	+3+/-2	0.005	100	
35	34*	CTU GSE 1 DATA (-)	+3+/-2	0.005	100	

T00311a

Table 3 -17 Pin Assignments, PAF Connector P201/A9J5A (Continued) (TBD)

Pin No.	Twisted and Shielded with(1)	Function	Volts	Amps	Max resistance To EEB (ohms)	Polarity Requirement
36	37*	CTU GSE CLOCK (+)	+3+/-2	0.005	100	
37	36*	CTU GSE CLOCK (-)	+3+/-2	0.005	100	
38	39*	GSE TLM 7.5V PWR	+8+/-1	0.1	1	
39	38*	GSE TLM 7.5V RTN	0+/-1	0.1	1	
40	41*	GSE TLM 7.5V PWR	+8+/-1	0.1	1	
41	40*	GSE TLM 7.5V RTN	0+/-1	0.1	1	
42	43-46	CARRIER TELEMETRY (+)	0 to +5	0.01	100	
43	42, 44-46	CARRIER TELEMETRY (-)	0 to +5	0.01	100	
44	42-43, 45-46	SUBCARRIER TELEMETRY (+)	0 to +5	0.01	100	
45	42-44, 46	SUBCARRIER TELEMETRY (-)	0 to +5	0.01	100	
46	42-45	SHIELD	N/A			
47		EXTERNAL PWR (+)	+30+/-5	3	0.5	
48		EXTERNAL PWR (-)	0+/-1	3	0.5	
49		EXTERNAL PWR (+)	+30+/-5	3	0.5	
50		EXTERNAL PWR (-)	0+/-1	3	0.5	
51		EXTERNAL PWR (+)	+30+/-5	3	0.5	
52		EXTERNAL PWR (-)	0+/-1	3	0.5	
53		EXTERNAL PWR (+)	+30+/-5	3	0.5	
54		EXTERNAL PWR (-)	0+/-1	3	0.5	
55		EXTERNAL PWR (+)	+30+/-5	3	0.5	
56		EXTERNAL PWR (-)	0+/-1	3	0.5	
57		EXTERNAL PWR (+)	+30+/-5	3	0.5	
58		EXTERNAL PWR (-)	0+/-1	3	0.5	
59		EXTERNAL PWR (+)	+30+/-5	3	0.5	
60		EXTERNAL PWR (-)	0+/-1	3	0.5	
61		SPARE				

Note:

(1) * indicates twisted only, otherwise twisted and shielded

T00311b

Table 3-18 Pin Assignments, PAF Connector P200/A9J5 (TBD)

Pin No.	Twisted and Shielded with(1)	Function	Volts	Amps	Max resistance To EEB (ohms)	Polarity Requirements
1		SPARE				
2		SPARE				
3		HLDC HZB SAFE CMD	+30+/-5	0.4	10	
4		HLDC BUSES OFF CMD	+30+/-5	0.3	10	
5		SPARE				
6		ESS BUS CURRENT MON	+3+/-2	0.001	100	
7		TANK PRESS MON	0 to +5	0.001	100	
8	9-11, 35	TANK TEMP MON (+)	+3+/-2	0.001	100	
9	8, 10-11, 35	TANK TEMP MON (-)	0+/-1	0.001	100	
10	8-9, 11, 35	BATT TEMP MON (+)	0 to +2	0.002	10	
11	8-10, 35	BATT TEMP MON (-)	0+/-1	0.002	10	
12		BAPS REL STATUS	30+/-5	0.005	100	
13	14-15*	SEP +15 V	+15+/-1	0.02	10	
14	13, 15*	SEP 15V RTN	0+/-1	0.01	10	
15	13-14*	SEP-15V	-15+/-1	0.02	10	
16		CPV-11 PRESSURE MON	0 to +5	0.001	100	
17		SEPARATED 1 + BOEING				
18		SEPARATED 1 - BOEING				
19		TEST CMD ECHO	+28+/-5	0.02	100	
20		SCC1 SEPARATION IND (+)				
21		SCC1 SEPARATION IND (-)				
22		NON ESS BUS CURRENT MON	+3+/-2	0.001	100	
23		SOLAR ARRAY CURRENT MON	+3+/-2	0.001	100	
24		TRANSPONDER 1 AUX CMD EN	+3+/-2	0.01	100	
25		TRANSPONDER 1 AUX CMD EN RTN	0+/-1	0.01	100	
26	27-29, 32	TRANSPONDER 1 AUX CMD SIG (+)	+3+/-2	0.01	100	
27	26, 28-29, 32	TRANSPONDER 1 AUX CMD SIG (-)	+3+/-2	0.01	100	
28	26-27, 29, 32	TRANSPONDER 2 AUX CMD SIG (+)	+3+/-2	0.01	100	
29	26-28, 32	TRANSPONDER 2 AUX CMD SIG (-)	+3+/-2	0.01	100	
30		TRANSPONDER 2 AUX CMD EN	+3+/-2	0.01	100	
31		TRANSPONDER 2 AUX CMD EN RTN	0+/-1	0.01	100	
32	26-29	SHIELD				
33		EMC EN STAT UMB	+30+/-5	0.003	100	
34		EMC FLAG UMB	0 to +5	0.001	100	
35	8-11	SHIELD				

T00321a

Table 3 -18 Pin Assignments, PAF Connector P200/A9J5 (Continued) (TBD)

Pin No.	Twisted and Shielded with (1)	Function	Volts	Amps	Max resistance To EEB (ohms)	Polarity Requirements
36		-Y SHORTING PLUG INST/NOT INST				
37		+Y SHORTING PLUG INST/NOT INST				
38		SPARE				
39		SPARE				
40		SPARE				
41		SPARE				
42		SPARE				
43		SPARE				
44		SPARE				
45		SPARE				
46		SPARE				
47		SPARE				
48		SPARE				
49		SPARE				
50		SPARE				
51		SPARE				
52		SPARE				
53		SPARE				
54		SPARE				
55		SPARE				
56		SPARE				
57		SPARE				
58		SPARE				
59		SPARE				
60		SPARE				
61		SPARE				

Note:

(1) * indicates twisted only, otherwise twisted and shielded

T00321b

Table 3-19 Structural Loads

	C. G. Limit Load Factors[1]	
Load Condition	**Axial (g)[2]**	**Lateral (g)**
Maximum Lateral	+2.8 / -0.2	+/- 3.5[3]
Maximum Axial	+7.3[4] +/- 0.6	+/- 0.1

Note:

(1) Limit load factors should be multiplied by a 1.25 factor to obtain ultimate loads.

(2) + denotes compression, - denotes tension

(3) Lateral load factor results in proper bending moment at the spacecraft separation plane.

(4) MECO steady-state load factor represents a 2135 lb ICESat spacecraft and a 370 lb CATSAT spacecraft.

T00329

Table 3-20 Maximum Flight Sinusoidal Vibration Levels

	Frequency (Hz)	Level
Thrust Axis	5 - 6.2	0.5 inch double amplitude
	6.2 - 100	1.0 $g_{0\text{-peak}}$
Lateral Axes	5 - 100	0.7 $g_{0\text{-peak}}$

Note:

- Accelerations apply at payload attach fitting base during testing. Responses at fundamental frequencies should be limited based on vehicle coupled loads analysis.

T00330

Table 3-21 Radio Frequency Environment at SLC-2W

Frequency Range	E-Field
14 kHz to 5.762 GHz	20 volts/meter
5.762 GHz to 5.768 GHz	40 volts/meter *
5.768 GHz to 40 GHz	20 volts/meter

* Second stage C-Band transponder

T00347

Table 3-22 Ground Handling Environmental Requirements (TBR)

Location		Temperature	Relative Humidity	Cleanliness
During Transport[1]		See Note [2]	See Note [3]	Not controlled[3]
Mobile Service Tower	**White Room (all doors closed)** [4]	60–5 F	40-60%	99.97% of all particles over 0.3μm. Class 100,000
	Environmental Shroud	55–5 F	40-60%	99.97% of all particles over 0.3μm. Class 10,000[5] [6]
	Fairing	55–5 F	40-60%[7]	99.97% of all particles over 0.3μm. Class 10,000[5] [6]

(1) GN2 purge of the handling can is required. DPAF is bagged (Boeing provided), and can is double bagged (Boeing provided).
(2) Not actively controlled. Passive temperature and humidity control provided by operational means and constraints.
(3) Dry gaseous nitrogen purge per MIL-P-27401C, Type 1, Grade B.
(4) Conditions are measured on the White Room wall.
(5) FED-STD-209E.
(6) Requirement driven by ICESat, CATSAT requires Class 100,000.
(7) RH level to be maintained prior to MST roll-back. After tower roll-back, RH level will be set so as to prevent condensation.

T00323

4 QUALITY ASSURANCE PROVISIONS

4.1 PHILOSOPHY OF VERIFICATION

Boeing will certify to the spacecraft supplier and user via a Flight Readiness Review that all hardware and software is operational and flight ready prior to launch.

4.2 VERIFICATION METHODS

4.2.1 DEMONSTRATION

Demonstration is the method used to verify requirements by exercising or operating the system or a part of the system using instrumentation or special test equipment inherently provided in the system being verified. In the demonstration method, sufficient data for requirements verification can be obtained by observation of the functional operation of the system. When this verification method generates data that is recorded by inherent instrumentation, inherent test equipment, or operational procedures, any analysis that must be performed using that data is verification by analysis as described in 4.3.

4.2.2 TEST

Test is the method used to verify requirements by exercising or operating the system or a part of the system using instrumentation (hardware and/or software) or special test equipment that is not an integral part of the system being verified. The test method by its nature generates data, which is recorded by the instrumentation, test equipment, or procedures. Analysis or review is performed on the data derived from testing. This analysis, as described here, is an integral part of this method and should not be confused with the analysis method described below.

4.2.3 ANALYSIS

Analysis is the method used to verify requirements by determining qualitative and quantitative properties and performance through studying and examining engineering drawings, software, and hardware flow diagrams, software and hardware specifications, and other software and hardware documentation (e.g., COTS vendor documentation), or by performing modeling, simulation, and/or calculations, and analyzing the results. Analysis techniques include interpretation or interpolation and extrapolation of analytical data or empirical data under defined conditions or reasoning to show compliance with requirements.

4.2.4 INSPECTION

Inspection is the verification by comparison of physical characteristics to specified design requirements. Inspection is normally used to verify construction features, workmanship, physical conditions or requirements, e.g. physical dimension, marking, wire coding, surface finish, etc.

4.2.5 SIMILARITY

Similarity is the verification by evaluation of analytical or test data from an analysis or test program for an item which is sufficiently similar to the required item for the data to be valid. The data must show that the item used as a basis for the verification has satisfied equivalent or more stringent requirements. Similarity is not shown as a drawing requirement, but is negotiated separately to satisfy specific requirements.

4.3 VERIFICATION MATRIX

Figure 4-1 presents the verification matrix for the requirements of this specification.

Table 4-1 Verification Matrix

Verification Level

DEV - Development
QAL - Qualification
ACC - Acceptance

NR - No Requirements in this paragraph to be verifiied

Verification Method

ANL - Analysis
SIM - Similarity
INS - Inspection
DEM - Demonstration
TST - Test
SPL - Special

Section 3 Requirements Paragraph		Verification										
			Verification Method						Verification Level			Section 4 Verification Paragraph
		NR	ANL	SIM	INS	DEM	TST	SPL	DEV	QAL	ACC	
3.1.2	Spacecraft Coordinate System											TBD
3.1.3.1	Weight, MOI, POI, and CG Location											TBD
3.1.3.2	CG Offset											TBD
3.1.4	Spacecraft Envelope											TBD
3.1.4.1	Fairing Envelope Violations											TBD
3.1.4.2	Separation Plane Envelope Violations											TBD
3.1.5	Spacecraft Energy Dissipation Sources											TBD
3.1.8.1	Ventable											TBD
3.1.8.2	Non-Ventable											TBD
3.1.9	Spacecraft Systems Activated Prior to Spacecraft Separation											TBD
3.2.1	Orbit Characteristics											TBD
3.2.2	Injection Accuracy											TBD
3.2.2.1	Probability of Command Shutdown											TBD
3.2.3.2.a	Thermal Attitude Constraints											TBD
3.2.3.2.b	Thermal Attitude Constraints											TBD
3.2.4.a	Spacecraft Separation Requirements											TBD
3.2.4.b	Spacecraft Separation Requirements											TBD
3.2.4.c	Spacecraft Separation Requirements											TBD
3.2.4.1.a	Sun Angle Constraints											TBD
3.2.4.1.b	Sun Angle Constraints											TBD
3.2.5.1	Launch Date											TBD
3.2.5.2	Launch Window											TBD
3.2.6	Launch Site											TBD
3.2.7.1.2	Spacecraft Ground Station Interface Requirements											TBD
3.2.7.1.3	Mission Critical Interface Requirements											TBD
3.2.7.3.2.a	Spacecraft Acquisition Assistance Requirements											TBD
3.2.7.3.2.b	Spacecraft Acquisition Assistance Requirements											TBD
3.3.1.1	Launch Vehicle Designation											TBD
3.3.1.2	Special Vehicle Insignia											TBD
3.3.2	Launch Vehicle Coordinate System											TBD
3.3.3.a	Dual Payload Attach Fitting Mission Specific Configuration											TBD
3.3.3.b	Dual Payload Attach Fitting Mission Specific Configuration											TBD
3.3.5.3	Standard Instrumentation											TBD
3.3.5.4	Insulation											TBD
3.3.6	First Stage Mission Specific Configuration											TBD
3.4.1	Responsibility											TBD
3.4.2.1.1	Access Doors and RF Windows in Fairing											TBD
3.4.2.1.2	External Fairing Insulation											TBD
3.4.2.1.3.1	Cylindrical Section											TBD
3.4.2.1.3.2	Nose Cone											TBD
3.4.2.1.3.3	Doors											TBD
3.4.2.1.4	Deflector/Diffuser											TBD
3.4.2.1.5	Fairing Instrumentation											TBD
3.4.2.2	Payload Attach Fitting Mission Specific Configuration											TBD
3.4.2.3	Contamination Barrier											TBD
3.4.2.4.1.a	Clampband System											TBD
3.4.2.4.1.b	Clampband System											TBD
3.4.2.4.1.c	Clampband System											TBD
3.4.2.4.2.a	Separation Springs											TBD
3.4.2.4.2.b	Separation Springs											TBD
3.4.3.1.1.a	Connector Type and Location											TBD
3.4.3.1.1.b	Connector Type and Location											TBD
3.4.3.1.2	Connector Pin Assignments											TBD
3.4.3.1.3	Spacecraft Separation Indications											TBD
3.4.4.1	Steady-State Acceleration											TBD
3.4.4.2	Structural Loads											TBD
3.4.4.3.1	Acoustic Environments											TBD
3.4.4.3.2	Vibration											TBD
3.4.4.3.3.a	Spacecraft Interface Shock Environment											TBD
3.4.4.3.3.b	Spacecraft Interface Shock Environment											TBD
3.4.4.4.1	Fairing Temperature and Emissivities											TBD
3.4.4.4.2	Free Molecular Heating Rate											TBD
3.4.4.5.a	RF Environment											TBD

Table 4-1 Verification Matrix (Continued)

Verification Level	Verification Method
DEV - Development QAL - Qualification ACC - Acceptance NR - No Requirements in this paragraph to be verifiied	ANL - Analysis SIM - Similarity INS - Inspection DEM - Demonstration TST - Test SPL - Special

Section 3 Requirements Paragraph		Verification										
			Verification Method						Verification Level			Section 4 Verification Paragraph
		NR	ANL	SIM	INS	DEM	TST	SPL	DEV	QAL	ACC	
3.4.4.5.b	RF Environment											TBD
3.4.4.6	Electrical Bonding											TBD
3.5.1	Temperature and Humidity											TBD
3.5.2.1.a	Air Conditioning											TBD
3.5.2.1.b	Air Conditioning											TBD
3.5.2.2.a	GN2 Purge											TBD
3.5.2.2.b	GN2 Purge											TBD
3.5.3.1.a	Cleanliness Category											TBD
3.5.3.1.b	Cleanliness Category											TBD
3.5.3.2	Spacecraft Environmental Shroud											TBD
3.5.3.3	Contamination Control Plan											TBD
3.5.4.2	Spacecraft Weighing											TBD
3.5.5	Facility Security											TBD
3.5.6	Special Handling Requirements											TBD
3.5.6.1	In Payload Processing Facility											TBD
3.5.6.2	During Transport											TBD
3.5.6.3	On Stand											TBD
3.5.7	Special Boeing Supplied Equipment and Facilities											TBD

5 NOTES

5.1 DEFINITIONS

5.2 ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ANSI	American National Standards Institute
Btu	British Thermal Unit
CATSAT	Cooperative Astrophysics and Technology Satellite
CG	center of gravity
CSM	Command Storage Memory
dc	direct current
DMR	Delta Mission Requirements
DPAF	dual payload attach fitting
EEB	Electrical Equipment Building
EOS	Earth Observing System
ft	foot
g	gravity
GLAS	Geoscience Laser Altimeter System
GPS	Global Positioning System
GSE	ground support equipment
GSFC	Goddard Space Flight Center
hr	hour
ICESat	Ice, Cloud, and Land Elevation Satellite
IFOV	instrument field of view
in.	inch(es)
in^3	cubic inches
kg	kilogram
km	kilometer
lbf	pounds force
lbs	pounds
LV	launch vehicle
MECO	main engine cut off
MGSE	mechanical ground support equipment
mJ	milliJoule
mm	millimeter
MOI	moment of inertia
MSPSP	Missile System Prelaunch Safety Package
MST	Mobile Service Tower
MW	megawatt

NASA	National Aeronautics and Space Administration
nm	nanometer
ns	nanosecond
OPM	orbital parameters message
PAF	payload attach fitting
PCC	Power Control Console
PCM	pulse code modulation
POI	product of inertia
PRD	Program Requirments Document
RF	radio frequency
RIFCA	Redundant Inertial Flight Control Assembly
RRS	Retain and Release System
SC	spacecraft
SCC	Spacecraft Control Computer
scfh	standard cubic feet per hour
sec	second
SLC-2W	Space Launch Complex 2W
STOC	Spacecraft Test and Operations Center
TBD	to be determined
TBR	to be resolved
TT&C	tracking, telemetry, and communication
VAFB	Vandenberg Air Force Base
W	watt

5.3 TBD/TBR LISTS

Where a requirement needs to be specified but is not yet established, the acronym "TBD" for "to be determined" is inserted. If there is doubt about the ability to meet a requirement stated, or doubt about the value of the requirement stated, the required values are followed by "TBR" for "to be resolved". Table 5-1 and 5-2 list the sections currently containing TBDs and TBRs.

Table 5-1 TBD List

Paragraph Number	Paragraph Title
3.1.4.1	Fairing Envelope Violations
3.1.5	Spacecraft Energy Dissipation Sources
3.1.8.1	Ventable
3.1.8.2	Non-Ventable
3.1.10	SPACECRAFT RF SYSTEMS ACTIVATED AFTER SPACECRAFT SEPARATION
3.2.4.1.b	Sun Angle Constraints
3.2.5.1	Launch Date
3.2.7.1.2	Spacecraft Ground Station Interface Requirements
3.2.7.1.3	Mission Critical Interface Requirements
3.3.6	First Stage Mission Specific Configuration
3.4.2.2	Payload Attach Fitting Mission Specific Configuration
3.4.2.4.1.c	Clampband System

Table 5-1 TBD List (Continued)

Paragraph Number	Paragraph Title
3.5.5	Facility Security
3.5.6	Special Handling Requirements
3.5.6.2	During Transport
3.5.7	Special Boeing Supplied Equipment and Facilities
5.3	TBD/TBR LISTS
Figure 3-7	Spacecraft/LV Separation Plane Interfaces (TBD)
Figure 3-8	Launch Vehicle Insignia (TBD)
Figure 3-13	Spacecraft Interface Design (TBD)
Table 3-2	Violations in the Fairing Envelope (TBD)
Table 3-3	Violations in the Separation Plane Envelope (TBD)
Table 3-4	Propellant Tank Characteristics (TBD)
Table 3-6	RF Transmitter and Receiver Characteristics (TBR/TBD)
Table 3-8	Contamination Sensitive Surfaces (TBD)
Table 3-12	Thermal Attitude Requirements (TBD,TBR)
Table 3-14	Launch Times (TBD)
Table 3-17	Pin Assignments, PAF Connector P201/A9J5A (TBD)
Table 3-18	Pin Assignments, PAF Connector P200/A9J5 (TBD)

Table 5-2 TBR List

Paragraph Number	Paragraph Title
3.1.2	Spacecraft Coordinate System
3.1.3.1	Weight, MOI, POI, and CG Location
3.1.6.1	Propulsion Systems
3.2.1	Orbit Characteristics
3.2.2	Injection Accuracy
3.2.3.2.a	Thermal Attitude Constraints
3.2.4.a	Spacecraft Separation Requirements
3.2.4.1.a	Sun Angle Constraints
3.3.5.4	Insulation
3.4.2.4.1.b	Clampband System
5.3	TBD/TBR LISTS
Table 3-1	Spacecraft Weight, MOI, POI, and CG Location (TBR)
Table 3-6	RF Transmitter and Receiver Characteristics (TBR/TBD)
Table 3-10	Orbit Characteristics (TBR)
Table 3-11	Orbit Dispersion Requirements (TBR)
Table 3-12	Thermal Attitude Requirements (TBD,TBR)
Table 3-13	Separation Requirements (TBR)
Table 3-22	Ground Handling Environmental Requirements (TBR)

10 APPENDIX A - SPACECRAFT TO BLOCKHOUSE WIRING DIAGRAM

F00362

TBD

Figure 10-1 Spacecraft-To-Blockhouse Wiring Diagram

20 APPENDIX B - SPACECRAFT COMPATIBILITY DRAWING

F00363

TBD

Figure 20-1 Delta II/Spacecraft Compatibility Drawing

Distribution List For MDC 99H0061, Ice, Cloud, and Land Elevation Satellite (ICESat) Mission Specification

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Walsh, Kristen	L353, Sp Trn - NASA/SDIO - Program Mgmt	H012-C225	714-896-4320